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HARVARD COLLEGE

VE RI TAS

SCIENCE CENTER
LIBRARY

RULES

Books and periodicals may be used in the Society rooms by members and friends.

Members may borrow books for home use—with the exceptions noted below—but no one shall have more than four books at any time, or keep any book more than two weeks.

Volumes belonging to a set—such as volumes of bound periodicals and of proceedings or transactions of societies—and such other books as the Board of Government may designate, may be taken from the rooms for a limited time only, by special arrangement with the attendant. They shall be subject to recall at any time.

There shall be no immediate renewal of any book on its return to the library.

A member borrowing a book shall at that time give a receipt therefor.

A fine of one cent per day per volume shall be charged for over-time, and must be paid before the delinquent can take any more books.

Hand books, indexes, current numbers or unbound files of periodicals, books belonging to the Clemens Herschel Special Library, and new books not yet placed on the regular shelves must not be taken from the rooms.

Books of unusual value are marked with a star (*), and must not be taken from the rooms, except by written permission from the Librarian, to be filed by the attendant.

Any person mutilating or losing a book shall pay for the damage, or replace the book.

Any one who violates the above rules may, upon written request fro [illegible] Board of Government, be debarred fro [illegible] for such time, not less than three [illegible] by the Government may determine.

(Revis [illegible]

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HARVARD COLLEGE LIBRARY
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BROOKLYN ENGINEERS' CLUB

ORGANIZED OCT. 9, 1896
INCORPORATED DEC. 29, 1896

PROCEEDINGS FOR 1916

CONSTITUTION AND BY-LAWS

AND

ANNUAL REPORT OF THE BOARD OF DIRECTORS

9497

PRICE, TWO DOLLARS

BOSTON SOCIETY
CIVIL ENGINEERS

Published by the BROOKLYN ENGINEERS' CLUB
Office of Secretary and Library of Club in the Club House.
117 Remsen Street, Brooklyn, New York

1917

E M Van Norden

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1917

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BOSTON SOCIETY
CIVIL ENGINEERS

BROOKLYN ENGINEERS' CLUB

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BROOKLYN ENGINEERS' CLUB

CONSTITUTION AND BY-LAWS.

ARTICLE I

NAME, LOCATION AND OBJECT

SECTION 1. The name of this Association shall be the "BROOKLYN ENGINEERS' CLUB."

SEC. 2. The offices of the Club shall be located in the Borough of Brooklyn.

SEC. 3. The object of the Club shall be to promote social and professional intercourse among its members; to advance engineering knowledge and practice, and to maintain a high standard of professional procedure in all respects.

SEC. 4. The means to be employed for this purpose shall be: Meetings for the presentation and discussion of appropriate papers and for social and professional intercourse; the publication of such papers and discussions as may be deemed expedient; the maintenance of a technical library, and such other means as may be deemed proper.

ARTICLE II

MEMBERSHIP

SECTION 1. The Club shall consist of Corporate, Associate, Non-Resident and Honorary Members.

SEC. 2. A Corporate member shall be a civil, military, naval, mechanical, electrical, mining or other engineer, architect, surveyor or analytical chemist, or a person who has taken a course in a technical school with the purpose of entering one of the above-mentioned professions. He shall be either a resident of Brooklyn, or one of the other Boroughs of the City of New York, or a practitioner therein, at the time of his election.

SEC. 3. An Associate member shall be a person residing, or doing business in Brooklyn, or another Borough of the City of New York, at the time of making his application, who has such a knowledge of or connection with applied science as qualifies him, in the opinion of the Board of Directors, to co-operate with engineers in the advancement of professional knowledge.

Sec. 4. A Non-Resident member shall be one possessing the qualifications enumerated in Sections 2 and 3, whose residence is outside of the City of New York; Commissioned Engineer Officers in the Military or Naval service of the United States may be elected to this grade of membership.

Sec. 5. A Corporate or Associate member who shall remove his residence to the distance stated in Section 4, may be transferred to the Non-Resident class at the beginning of the fiscal year following such removal, provided notice of the removal be filed with the Secretary at the time of payment of the annual dues, or not later than February 1st.

Sec. 6. A Non-Resident member who shall remove his residence to within the City of New York, shall become a full member in the same manner as specified in Article III, but shall not be required to pay an entrance fee. Provided, however, that his application for full membership shall be filed within three (3) months of his removal, otherwise his name will be dropped from the roll of the Club by the Board of Directors at the beginning of the next calendar year, except that no action shall be taken unless a copy of this section shall have been served upon him at least four (4) weeks prior to such action.

Sec. 7. Honorary members shall be chosen from persons resident in Brooklyn, of acknowledged eminence in the pursuit of their profession, or on account of their contributions to the welfare of the community along professional or municipal lines. There shall not be more than five (5) Honorary members at any one time.

Sec. 8. Associate, Non-Resident and Honorary members shall not be entitled to vote or hold office, but shall enjoy all other Club privileges.

ARTICLE III

ADMISSIONS AND EXPULSIONS

Section 1. An application for admission to the Club as a Corporate member or for transfer from the Non-Corporate to the Corporate grade, shall embody a concise statement, with dates, of the candidate's professional training and experience, and shall be in a form and in such detail as may be prescribed by the Board of Directors. It shall be signed by the applicant, and shall contain a promise to conform to the requirements of membership if elected. The applicant shall give at least three (3) references, two of whom shall be Corporate members in good standing.

Sec. 2. At the time of giving notice of the regular meetings of the Club, the Secretary shall issue to each member, in any grade, whose address is known, a list of all new applications received up to that time for membership in any grade or for transfer from one grade to another, which list shall be dated and shall contain a statement of the name, address, and present employment of each applicant and the names of his references, with a request that members transmit to the Membership Committee any information in their possession which may affect the disposition of the applications.

Not less than twenty days after the date of issue of such list the Membership Committee shall make a report in writing upon each of these applications to the Board of Directors, who shall, at the next meeting, consider the reports received, and, if approved by them, shall direct a ballot.

Sec. 3. The ballots shall be letter ballots, in a form to be prescribed by the Board of Directors. They shall be mailed to each Corporate member whose address is known, and shall state the date on which the ballot is to be canvassed.

A four-fifths vote of those voting shall be necessary for election. In case of a candidate failing of election, no notice thereof shall be entered in the minutes, but the candidate shall be notified.

Sec. 4. The application of any candidate, once rejected, shall not be considered by the Board of Directors, within one year, unless the same be accompanied by a request signed by not less than five (5) Corporate members asking for a reconsideration of the ballot, and stating the reason for such request. The Board of Directors, shall it deem those reasons sufficient, shall present said application at the next regular meeting of the Club, with the request that it be acted upon.

Sec. 5. All elected candidates shall be duly notified and shall subscribe to the Constitution and Rules of the Club.

If these provisions are not complied with within thirty (30) days from the notification of election, such election shall be considered void unless, for special reasons, the time shall be extended by the Board of Directors. Membership of any person shall date from the day of his election.

Sec. 6. Honorary members shall be proposed by the Secretary upon the unanimous recommendation of the Board of Directors at a regular meeting, and be balloted upon at the next regular meeting. Four-fifths (4-5) of the votes cast shall be necessary for an election.

A person elected an Honorary member shall be promptly notified thereof by letter; the election shall be canceled if an acceptance is not received within ninety (90) days after mailing such notice.

Sec. 7. Upon the written request of six or more Corporate members, that for cause therein set forth a person belonging to the Club be expelled, the Board of Directors shall consider the matter, and if there appear to be sufficient reason, shall advise the accused of the charges against him. He may, if he so desire, present a written defense, which shall be considered at a meeting of the Board of Directors, of which he shall receive due notice and at which he may appear with counsel. Unless the Defense made be satisfactory to the Board of Directors, they shall, after two months have elapsed, unless his resignation has already been tendered, notify the person that he must present the same within thirty (30) days, or he will then be expelled.

An appeal may be taken against such a course, in which case a special meeting will be called for the purpose of submitting to the Club all the evidence in the case. A majority of the votes cast at the special meeting will be required to sustain the action of the Board. The Secretary will notify all Corporate members of the Club of the result of the ballot. In case no appeal be made, the Board of Directors will expel the person, and notify him and the Corporate members of its action.

Sec. 8. A member of any grade in the Club may resign his membership by a written communication to the Secretary, who shall present the same to the Board of Directors; when, if his dues have been paid, his resignation will be accepted.

ARTICLE IV

ENTRANCE FEES AND DUES

Section 1. The dues on admission to the Club and yearly thereafter shall be:

For Corporate member, Twelve (12) Dollars.
For Associate member, Twelve (12) Dollars.
For Non-Resident member, Five (5) Dollars.

Sec. 2. Corporate, Associate and Non-Resident members shall pay an entrance fee of Ten (10) Dollars upon admission to the Club. The Board of Directors shall have the power to suspend or reduce the amount of this initiation fee.

The annual dues shall be payable for the ensuing year on the first day of January.

It shall be the duty of the Secretary to notify each member of the amount due for the ensuing year at the time of giving notice of the annual meeting.

SEC. 3. A person elected after six months of any fiscal year shall have expired shall pay only one-half of the amount of dues for that fiscal year.

SEC. 4. Any person whose dues are more than one month in arrears shall be notified by the Secretary. Should his dues not be paid when they become three months in arrears, he shall lose all Library privileges secured through the membership in the Club, and lose his right to vote. Should his dues become four months in arrears he shall again be notified in form prescribed by the Board of Directors, and should such dues become six months in arrears he shall forfeit his connection with the Club. The Board of Directors may, for cause deemed by them sufficient, extend the time for payment and for application of these penalties. The Board of Directors may remit the dues of members actively in the Federal service in time of war.

SEC. 5. Every member admitted to the Club shall be considered as belonging thereto, and liable for payment of dues until he shall have resigned or been expelled therefrom.

ARTICLE V

OFFICERS

SECTION 1. The officers of the Club shall be a President, Vice-President, Secretary and Treasurer, who, with the retiring President, and two Corporate members elected by the Club, shall constitute a Board of Directors, in which the government of the Club shall be vested, and who shall be the Directors as provided for by the laws under which the Club is incorporated; there shall also be an Auditing Committee of three members.

SEC. 2. The President shall be ineligible for election to two successive terms of office.

SEC. 3. The term of office for all officers shall be one (1) year, except for the Vice-President, who shall hold office for two (2) years.

Sec. 4. A vacancy in the office of the President shall be filled by the Vice-President.

Sec. 5. At the first annual meeting there shall be elected a Trustee, who shall act as a member of the Board of Directors and shall serve for one year. Any vacancy occurring in the Board by resignation, death or otherwise, shall be filled for the unexpired term by its remaining members.

Sec. 6. All officers shall be elected by ballot.

Sec. 7. The Board of Directors may appoint a Librarian.

ARTICLE VI

MANAGEMENT

Section 1. The President, acting under the direction of the Board of Directors, shall exercise a general supervision over the affairs of the Club. He shall preside at all business meetings of the Club and Board of Directors, at which he may be present, call special meetings when the same may be necessary, and appoint such committees as are herein provided for. He shall act as ex-officio member of all committees which he shall appoint.

Sec. 2. The Vice-President shall preside at business meetings in the absence of the President.

Sec. 3. The Board of Directors shall manage the affairs of the Club in conformity to the laws under which the Club is incorporated, and the provisions of this Constitution. They shall direct the investment and care of the funds of the Club; make appropriations for specific purposes; act upon applications for membership as heretofore provided, and generally conduct the business of the Club. The Board of Directors shall make an annual report at the annual meeting, transmitting the reports of the Secretary, the Treasurer, the Auditing and other committees.

Sec. 4. The Secretary, under the direction of the President and the Board of Directors, shall be the executive officer of the Club. He shall keep a record of all business meetings. He shall notify the members of all meetings and postponements thereof, and of all other matters as directed by the President and the Board of Directors. It shall also be his duty to take charge of and preserve all papers read and discussed, and, when directed by the Board of Directors, prepare copies or abstracts of the same for publication.

He shall see that all moneys due the Club are collected and transferred to the Treasurer. He shall verify the correctness of all bills presented for payment and charge same to the proper appropriations. He shall have charge of the books of account of the Club, and shall furnish to the Board of Directors a statement of receipts and expenditures under their several headings annually and at such other times as the Board may direct. He shall conduct the correspondence of the Club and keep full record of the same. He shall perform such other duties as may from time to time be assigned to him by the Board of Directors.

SEC. 5. The Treasurer shall be the custodian of the funds of the Club. He shall receive all moneys collected by the Secretary, and deposit the same to the credit of the Club in such depository as may be directed by the Board of Directors. He shall pay all bills, duly approved, by check, countersigned by the President, and shall keep book accounts of his receipts and expenditures, which shall be at all times open to inspection by the Board of Directors. He shall present a monthly report to the Board showing the receipts and expenditures during the previous month and the balance in his hands at the time of making such report. He shall make an annual report to be presented to the Club by the Board of Directors.

SEC. 6. The Auditing Committee shall, at the close of the fiscal year, audit the accounts of the Secretary and of the Treasurer.

SEC. 7. The Librarian shall have direct charge of all books, periodicals, transactions and other publications contained in the Library, subject to the direction of the Library Committee.

SEC. 8. The President, within ten days after the annual meeting, shall appoint a House Committee of three, a Library Committee of three, a Committee on New Membership of three, an Entertainment Committee of three, and an Excursion Committee of three members of the Club, which Committees shall be subject to the direction of the Board of Directors. All Committees shall hold office until their successors are appointed.

SEC. 9. The House Committee shall have general charge of the House and of the renting of such rooms as may be available for that purpose.

It shall arrange and provide for all Dinners, Collations or other social functions that may be held under Club auspices.

It shall act as a Reception Committee at all meetings of the Club, insuring visitors proper attention.

Sec. 10. The Library Committee shall have general charge of the Library, and shall take the necessary steps to procure all books, periodicals, transactions, reports, publications, etc., etc., that may be needed; present prior to the annual meeting a report to the Board of Directors, showing the increase in the Library during the year, and a statement of the moneys expended; also present an estimate of the moneys needed for Library purposes for the coming year.

Sec. 11. The Committee on New Membership shall investigate the fitness of all candidates for membership that may be referred to them by the President, see that the objects and advantages of the Club are at all times kept before the community in a proper spirit, and, generally, see that the Club preserves a healthy and desirable growth.

Sec. 12. The Entertainment Committee shall provide suitable papers to be presented before the Club at its regular meetings, and speakers for the Informal or Library Talks on such other dates as may be desirable.

Sec. 13. The Excursion Committee shall arrange and provide for all excursions, outings, or inspection trips of the Club and shall notify the Secretary in time for ample notice to the membership of such arrangements.

Sec. 14. The Secretary and the Librarian shall receive such compensation for their services as the Board of Directors may determine; but such compensation, when fixed, shall not be reduced during the term of office, as provided in this Constitution. All other salaries shall be fixed, from time to time, by the Board of Directors.

ARTICLE VII

MEETINGS

Section 1. There shall be eight (8) regular meetings of the Club per annum, to be held on the second Thursday in each month, except during the months of June, July, August and September.

Sec. 2. The annual meeting, at which the officers for the ensuing year shall be elected and all annual reports read, shall be held on the second Thursday in December in each year.

Sec. 3. Whenever the President shall deem it necessary, or upon the written application of five (5) Corporate members, he shall direct the Secretary to call a special meeting. The notice thereof shall state the time and place of holding the meeting and the purpose for which it is called, and shall be mailed not less than five days previous to the date of the proposed meeting.

Sec. 4. At all regular and special meetings of the Club, ten (10) Corporate members shall constitute a quorum.

Sec. 5. The Club may adopt, from time to time, rules for the order of business at its meeting.

Sec. 6. At the regular or special meeting of October, 1897, and annually thereafter, a committee of five (5) Corporate members shall be elected by the members present to make nominations for officers to be balloted for at the ensuing annual election. Said Committee shall report their list of nominations at the regular meeting in November, and the list shall be sent to each Corporate member by the Secretary, in the regular notification of the annual meeting. And it shall be the duty of the Secretary to send with such nominations any other nominations, on the written request of five (5) Corporate members filed with him ten (10) days before the date of the annual meeting. The said notices shall be mailed by the Secretary one week before the annual election.

In the event of failure to elect a Nominating Committee at an October meeting, it shall be the duty of the Board of Directors to appoint such committee.

ARTICLE VIII

AMENDMENTS

Section 1. Proposed amendments to this Constitution must be reduced to writing and signed by not less than five (5) Corporate members, and be submitted and acted upon as follows:

Sec. 2. The amendment, as proposed, shall be sent by letter to the several Corporate members, with the statement that the matter will come up before the next regular meeting for discussion unless otherwise ordered.

Sec. 3. At the discussion the proposed amendment may be amended in any way by a majority of those present and voting.

Sec. 4. The amendment, as amended, shall then be sent by letter to the several Corporate members, wherein the meeting for final action thereon will be announced. When final action is taken, a two-thirds (2-3) vote in favor of said amendment, as amended, will be necessary for its adoption.

FIRST OFFICERS.

Temporary President, ANDREW J. PROVOST, JR.

Temporary Secretary, WILLIAM G. FORD

Temporary Treasurer, GEORGE W. TILLSON

Committee on Constitution and By-Laws and Committee on Library

*A. J. CALDWELL
WALTER M. MESEROLE
GEORGE W. TILLSON
A. J. PROVOST, JR.
WILLIAM G. FORD

Committee on Incorporation

A. J. PROVOST, JR.
WILLIAM G. FORD

CHARTER MEMBERS.

O. F. Balston
Herbert J. Barker
Fred L. Bartlett
Homer L. Bartlett
W. L. Beers
William E. Belknap
R. T. Betts
Francis Blossom
J. C. Brackenridge
*David Brower
*William T. Bruorton
Edmund J. Burke
*Andrew J. Caldwell
D. Frederick Carver
*Frank J. Conlon
Albert S. Crane
Frederick A. Drake
John H. Dwyer
William G. Ford
Edwin J. Fort
Arthur J. Griffin
Thomas S. Griffin
Walter R. Griffith
George T. Hammond
Arthur S. Ives
Carl A. Johnson
Jacob Stinman Langthorn
*J. Calvin Locke
*Edward L. Maltby
James C. Meem
Walter M. Meserole
*Peter Milne
Frank O. Nowaczek
Arthur I. Perry
Frederick E. Pierce
Clarence D. Pollock
Andrew J. Provost, Jr.
*G. S. Roberts
George F. Rowell
Joseph Strachan
Edwin C. Swezy
George W. Tillson
*Kenneth Torrance
Arthur S. Tuttle
William D. Vanderbilt
*John H. Van der Veer
Bernard M. Wagner
E. Sherman White
Richard L. Williams
George E. Winslow

---

* Deceased.

PAST PRESIDENTS.

*Andrew J. Caldwell, 1897
Nelson P. Lewis, 1898
Walter M. Meserole, 1899
George W. Tillson, 1900
Joseph Strachan, 1901
William G. Ford, 1902
Andrew J. Provost, Jr., 1903
*Othniel F. Nichols, 1904
Richard S. Buck, 1905
Willard S. Tuttle, 1906
Clarence D. Pollock, 1907
George C. Whipple, 1908
James C. Meem, 1909
George A. Orrok, 1910
Winfred H. Roberts, 1911
William T. Donnelly, 1912
James W. Nelson, 1913
Edwin J. Fort, 1914
J. S. Langthorn, 1915
Ernest M. Van Norden, 1916

OFFICERS, 1916.

President, Ernest M. Van Norden
Vice-President, G. Laurence Knight
Secretary, Joseph Strachan
Treasurer, Harry E. Funk

Auditing Committee,
Edward A. Byrne
Frederick C. Noble
Calvin C. Hough

BOARD OF DIRECTORS

Ernest M. Van Norden
G. Laurence Knight
Joseph Strachan
Harry E. Funk
Bernt Berger
Carroll S. Dunphe
J. S. Langthorn

STANDING COMMITTEES

Library, A. C. Davis, A. C. Codet, C. M. Enderby
House, M. J. Shugrue, F. L. Hough, W. T. Chevalier
Membership, C. Lobo, J. Barth Cronin, C. A. Snyder
Entertainment, Bernt Berger, F. W. Skinner, C. H. Stevens
Excursion, A. W. Welch, H. E. Moore, G. A. Hughes

SPECIAL COMMITTEE

Committee on Award of the Alfred T. White Prize,
W. T. Donnelly, W. H. Roberts, H. W. Woodcock

---

* Deceased.

OFFICERS, 1917.

President, BERNT BERGER
Vice-President, HARRY E. FUNK
Secretary, JOSEPH STRACHAN
Treasurer, CARROLL S. DUNPHE

Auditing Committee,
CARLETON A. GRAVES
CARLOS LOBO
HOWARD P. QUICK

BOARD OF DIRECTORS

BERNT BERGER
HARRY E. FUNK
JOSEPH STRACHAN
CARROLL S. DUNPHE
WILLIAM J. CONWAY
MICHAEL J. SHUGRUE
ERNEST M. VAN NORDEN

STANDING COMMITTEES

Library, A. C. DAVIS, C. M. ENDERBY, G. S. TAYLOR
House, H. B. MORRISON, C. C. HOUGH, WM. M. WEPFER
Membership, G. WEIDERMAN, G. L. KNIGHT, C. H. STEVENS
Entertainment, J. B. FRENCH, H. C. KEITH, F. L. HOUGH
Excursion, J. BARTH CRONIN, WM. J. CONWAY, J. J. MEAD

SPECIAL COMMITTEE

Committee on Award of the Alfred T. White Prize,
J. W. NELSON, J. C. MEEM, A. J. PROVOST, JR.

PAST AND PRESENT OFFICERS AND THE YEARS DURING WHICH THEY HELD OFFICE.

Name.	President.	Vice-President	Secretary	Treasurer	Director	Librarian	Committee Auditing
Andrews, William					1910		
Barney, Percy C.					1915		1911
Berger, Bernt	1917				1916		
Brush, William W.				1913–15			1912
Buck, Richard S.	1905				1906		
Byrne, Edward A.							1916
*Caldwell, Andrew J.	1897				1898		
Carmalt, Laurence J.					1906		
*Conlon, Frank J.						1907–11	
Conway, William J.					1917		
Cranford, Frederick L.							1910
Donnelly, William T.	1912			1908–11	1913		
Dunphe, Carroll S.				1917	1916		1915
Ford, William G.	1902			1897–98	1903		
Fort, Edwin J.	1914				1908&15		
Funk, Harry E.		1917		1916			
Graves, Carleton A.					1915		1917
Hartung, George A.							1910
Hough, Calvin C.							1916
Keith, Herbert C.					1911		
Knight, G. Laurence		1915–16			1913–14		
Koop, Frederick W.							1913
Langthorn, J. S.	1915				1913&16		1914
Lewis, Nelson P.	1898				1899		
Lobo, Carlos							1917
Martin, Kingsley L.		1907–08			1906		
Meem, James C.	1909				1907&10		
Meserole, Walter M.	1899	1897–98			1900		
Middleton, John				1903–07			
Moran, Harry P.							1912
Nelson, James W.	1913			1912	1908,09&14		
*Nichols, Othniel F.	1904				1905		
Noble, Frederick C.					1910		1916
*Oestreich, Henry L.							1914
Orrok, George A.	1910				1911		
Perry, Arthur I.						1901–04	
Pollock, Clarence D.	1907	1905–06			1908		
Provost, Andrew J., Jr.	1903		1897–02		1904		
Quick, Howard P.							1917
Rice, Calvin W.				1899–00			
Roberts, Winfred H.	1911	1909–10			1912		
Schmitt, Jacob						1905–06	1910
Schmidt, H. H.							1914
Seaman, Henry B.		1899–00					1915
Shaler, E. Conway					1907		
Sheridan, John C.							1911
Shugrue, Michael J.					1917		
Sloan, Frank T.							1915
Spofford, Charles M.					1909		
Stein, John B.					1914		1913
*Steinmetz, John M.		1911–12					
Strachan, Joseph	1901		1903–17		1901–17		
Tillson, George W.	1900				1907		
*Torrance, Kenneth					1897		
Tuttle, Willard S.	1906	1901–02			1907		
Van Norden, E. M.	1916	1913–14			1912&17		
Ward, Charles R.							1911
Wells, Walter F.					1911		
Whipple, George C.	1908			1901–02	1909		
Williams, R. L.							1912–13
Woodcock, Henry W.					1912		
Woodward, Frederick S.		1903–04					

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*Deceased.

LIST OF MEMBERS.

(Corrected to December 1, 1917)

W Before name of member awarded the Alfred T. White prize.

HONORARY MEMBER

		Date of Election
	White, Alfred T. 40 Remsen St., Brooklyn, N. Y.	May 12, 1898

CORPORATE MEMBERS.

A	**Abraitys, George.** Asst. Engineer, Public Service Commission, 154 Nassau St., N. Y.	Apr. 11, 1912
A	**Allyn, Robert** S. President, National Metal-Fabric Co., 16 Exchange Pl., N. Y.	Oct. 14, 1909
	Ambler, Thomas M. Manager, Brooklyn Union Gas Co., Brooklyn, N. Y.	May 14, 1914
A	**Anderson, Chas.** M. Edison Elec. Ill. Co., 265 Madison St., Brooklyn, N. Y.	Oct. 12, 1911
	Andrews, William. Consulting Engineer, 120 Liberty St., N. Y.	June 19, 1902
	Ankener, Richard. Transitman, Department of Water Supply, Gas & Electricity, Brooklyn, N. Y.	Nov. 10, 1904
	Ashton, Walter, 9414 Glenwood Road, Brooklyn, N. Y.	Feb. 8, 1912
	Barnes, David W. Vice-Pres., Garwood Elec. Co., 90 West St., N. Y.	Nov. 14, 1907
	Barney, Percy C. Prin. Asst. Engr., Board of Water Supply, 2221 Municipal Bldg., N. Y.	Feb. 9, 1905
	Bartlett, Homer L. Civil Engineer and City Surveyor, 189 Montague St., Brooklyn, N. Y.	Nov. 6, 1896
A	**Bartlett, Homer** N., Assistant to H. L. Bartlett, City Surveyor, 189 Montague St., Brooklyn, N. Y.	Jan. 13, 1916
	Beattie, James G. 581 Amersfort Pl., Brooklyn, N. Y.	May 14, 1908
	Berger, Bernt. Civil Engineer, 45 Broadway, N. Y.	Apr. 1, 1897
	Berry, George. Asst. Engineer, Bureau of Highways, 78 Morton St., Brooklyn, N. Y.	Jan. 8, 1903
	Bie, Emil. Designer, Public Service Commission, New York City, 159 Willoughby Ave., Brooklyn, N. Y.	Jan. 8, 1914
A	**Biglin, Thos.,** 528 Carlton Ave., Brooklyn, N. Y.	May 9, 1912
	Bischof, George J. Asst. Engineer, Borough President's Office, Brooklyn, 471 Ocean Parkway, Brooklyn, N. Y.	Oct. 14, 1909
	Bleistein, Bernard J. Assistant Engineer, Department of Water Supply, Gas & Electricity, Brooklyn, N. Y.	Mar. 9, 1916
	Blount, Irving. 444 East 19th St., Brooklyn, N. Y.	Feb. 8, 1906
	Blunt, Edmund H. General Chemical Company, 25 Broad St., N. Y.	Mar. 14, 1907
	Bondinello, Lawrence D. Surveyor, Brooklyn Rapid Transit Company, Brooklyn, N Y.	Sept. 13, 1917
	Booth, William L. Subsurface Expert, Public Works Dept. U. S. Navy Yard, Boston, Mass.	May 13, 1909

A—In war service—Army
N—In war service—Navy

	Date of Election
Bowyer, Edward C. K., Draftsman for Interborough Rapid Transit Co., 50 Park Pl., N. Y.	Oct. 14, 1915
Boyrer. William C. Public Service Commission, 154 Nassau St., N. Y.	Jan. 10, 1901
Brackenbridge, J. C. Consulting Engineer, 95 Liberty St., N. Y.	Nov. 6, 1896
Brainerd, J. Willard. Structural Engineer, 92 Lincoln Road, Brooklyn, N. Y.	Jan. 12, 1905
Broadhurst, Wm. H. Chemist, Bureau of Highways, 50 Court St., Brooklyn, N. Y.	Mar. 14, 1897
Brower, Edward S. 95 Liberty St., N. Y.	Jan. 14, 1904
Brown, Garry E. Electrical Engineer, Edison Elec. Ill. Co., 360 Pearl St., Brooklyn, N. Y.	Mar. 11, 1915
A **Brown, Lewis P.** 596 East 22nd St., Brooklyn, N. Y.	May 10, 1906
Brown, Louis L. 77 Buckingham Road, Brooklyn, N. Y.	Mar. 12, 1914
Brush, William W. Deputy Chief Engineer, Dept. Water Supply, 2455 Municipal Bldg., N. Y.	Feb. 13, 1902
A **Buck, Richard S.** New York Railways Company, 165 Broadway, N. Y.	May 9, 1901
Byrne, Edward A. Asst. Chief Engineer, Dept. of Bridges, Municipal Bldg., N. Y.	Mar. 11, 1915
Cain, Charles. 947 East 22nd St., Brooklyn, N. Y.	May 8, 1913
Campbell, Daniel, Jr. Plan Examiner, Bureau of Buildings, Jackson Ave. and 5th St., Long Island City, N. Y.	Apr. 13, 1905
A **Carlin, Jos. P.** Secretary and Treasurer, P. J. Carlin Construction Co., 1123 Broadway, N. Y.	Nov. 10, 1904
Carroll, James J. Inspector, Engineering Dept. of Edison Elec. Ill. Co. of Brooklyn, N. Y., 915 Bedford Ave., Brooklyn, N. Y.	Mar. 13, 1913
Carson, Harry Y. Central Foundry Company, 90 West St., N. Y.	Apr. 12, 1917
Chapple, Charles E. Engineer, Brooklyn Union Gas Co., 1448 E. 10th St., Brooklyn, N. Y.	May 14, 1914
A **Chevalier, Willard T.** Asst. Engr., American Bitumastic Enamels Company, Inc., 17 Battery Pl., N. Y.	Oct. 11, 1906
Clark, Edwin Perry. Title Guarantee & Trust Co., 175 Remsen St., Brooklyn, N. Y.	Apr 10, 1913
Clark, Robert G., 45 South Elliott Pl., Brooklyn, N. Y.	Feb. 8, 1917
Clark, S. Milton. Asst. Engineer, Griggs & Myers, Consulting Engineers, 110 West 40th St., N. Y.	Jan. 9, 1913
Clausnitzer, John. 55 Bay 34th St., Brooklyn, N Y.	Jan. 8, 1903
Codft, Alexander C. Asst. Engineer, Dept. of Bridges, Municipal Bldg, N. Y.	Jan. 9, 1913
Collins, Augustus W. Cost accountant, H. Coppers Company, Pittsburg, Pa.	Nov. 8, 1917
Collins, Peter J. Builder, 135 Westminster Road, Brooklyn, N. Y.	Mar. 11, 1909
Conn, Frank W. 81 Willoughby St., Brooklyn, N. Y.	Apr. 13, 1899

	Date of Election
Conway, W. J. President, Stanwood Towing Co., 17 State St., N. Y.	Feb. 10, 1910
Cook, Henry C. Superintendent, John H. Duncan, contractor, Brooklyn, N. Y.	Sept. 13, 1917
Corsa, Lawrence J. 13 Shipley St., Woodhaven, L. I., Public Service Commission as Inspector of Electric Meters for State of New York	Jan. 9, 1913
Crane, Albert S. Hydraulic Engineer, J. G. White & Co., 43 Exchange Pl., N. Y.	Oct. 9, 1896
Cranford, Frederick L. Contractor, 149 Remsen St., Brooklyn, N. Y.	Oct. 14, 1909
Crocker, Calvin I. Asst. Engineer, Dept. of Bridges, 179 Washington St., Brooklyn, N. Y.	Apr. 14, 1904
Cronin, J. Barth. Supt. and Engineer, Barth S. Cronin, 573 Clinton St., Brooklyn, N. Y.	Oct. 12, 1911
Crosby, Hewitt. Civil Engineer, Atlantic, Gulf & Pacific Co., Park Row Bldg., N. Y.	Jan. 8, 1914
Cunningham, Wallace M. Inspector, Brooklyn Union Gas Company, Brooklyn, N. Y.	Sept. 13, 1917
Curtin, William H. 331 Adams St., Brooklyn, N. Y.	July 9, 1914
Cushman, Oliver W. Edison Electric Ill. Company, Brooklyn, N. Y.	Sept. 13, 1917
Darbee, Wm. Electric Bond and Share Co., 71 Broadway, N. Y.	Feb. 4, 1897
Davis, Arthur C. Irving Iron Works Company, 933 East 22nd St., Brooklyn, N. Y.	Oct. 10, 1912
Dawkins, Chas. C. Office of Construction Engineer, Brooklyn Union Gas Company, 176 Remsen St., Brooklyn, N. Y.	July 9, 1914
Dennington, Fred C. City Surveyor, 204 Montague St., Brooklyn, N. Y.	Feb. 11, 1904
Dill, Arthur H. Chief Engineer, Ford Instrument Company, N. Y.	May 10, 1917
Dill, Henry. Civil Engineer, 189 Montague St., Brooklyn, N. Y.	Oct. 9, 1913
Dixon, De Forest H. 71 Gates Ave., Montclair, N. J.	May 14, 1908
Donald Wm. H. 727 Quincy St., Brooklyn, N. Y.	May 12, 1910
Donnelly, J. A. Heating Engineer, 132 Nassau St., N. Y.	May 11, 1911
W Donnelly, Wm. T. Consulting Engineer, Rooms 930-932-934, 17 Battery Pl., N. Y.	Oct. 13, 1904
W Doron, Charles S. Engineer in Charge, Department of Parks, Borough of Brooklyn, N. Y.	Jan. 14, 1909
Dow, Allan W. Consulting Engineer and Chemist, 131 East 23rd St., N. Y.	Feb. 11, 1915
Drake, Frederick A. Bureau of Highways, 446 80th St., Brooklyn, N. Y.	Oct. 9, 1896
Drew, John A. Engineer and Sales Agent, Epping-Carpenter Pump Co., 90 West St., N. Y., President, Castle Heights Water Co., 45 St. Johns Pl., Brooklyn, N. Y.	Feb. 4, 1897

	Date of Election
Duff, Malcoln F. Walter Kidde & Company, N. Y.	Oct. 11, 1917
Duncan, John H., 657 61st St., Brooklyn, N. Y.	Jan. 12, 1911
Dunphe, Carroll S. 212 East Third St., Brooklyn, N. Y.	Mar. 14, 1907
Dwyer, John H. Assistant Engineer, New York Municipal Railway Corporation, 85 Clinton St., Brooklyn, N. Y.	Nov. 6, 1896
Dybvig, Karl J. Chief Draughtsman, Estimating Dept., Lidgerwood Mfg. Company, N. Y.	May 10, 1917
Eisenbraun, Geo. W. Asst. Engineer, W. T. Donnelly, 17 Battery Pl., N. Y.	Apr. 14, 1910
Elting, Oscar R. Civil Engineer, 76 Hurlburt Ave., Akron, Ohio	Apr. 8, 1915
Enderby, Claude M. Phoenix Construction Company, N. Y., 7420 Tenth Ave., Brooklyn, N. Y.	Jan. 12, 1911
A **Ennis, William D.** Prof. Mechanical Eng., Polytechnic Institute, Brooklyn, N. Y.	Jan. 9, 1908
Evers, C. Rudolph. Civil Engineer, 1138 Hancock St., Brooklyn, N. Y.	Jan. 9, 1908
Farley, Philip P. 1377 Carroll St., Brooklyn, N. Y.	Jan. 9, 1913
Farmer, Alexander S. Assistant Engineer, Board of Water Supply, N. Y.	Feb. 11, 1909
Fielder, Martin J. Interborough Rapid Transit Company, N. Y.	Apr. 12, 1917
Fisher, Francis D. Engineer, Degnon Contracting Co., 68 Hunter's Point Ave., Long Island City, N. Y.	Jan. 12, 1905
Fliflet, Thorlief. Walter Kidder, Engineer Constructor, 140 Cedar St., N. Y.	Apr. 14, 1910
A **Forbes, Arthur C.** Principal Asst. Engr. Topographical Bureau, Borough President's Office, Brooklyn, N. Y.	Feb. 13, 1902
Ford, William G. Consulting Engineer, 41 Second Ave., Pelham, N. Y.	Oct. 9, 1896
Ford, Thos. P. 47 Brevoort Pl., Brooklyn, N. Y.	Jan. 13, 1910
Fort, Edwin J. Chief Engineer, Bureau of Sewers, Mechanics Bank Bldg., Brooklyn, N. Y.	Nov. 6, 1896
Fox, Arthur C. 175 Claremont Ave., N. Y.	Apr. 11, 1907
Freeman, Milton H. Resident Engineer, Public Service Commissioner, 1st District, Alexander Ave., White Plains, N. Y.	Mar. 11, 1915
French, Edmund M. Asst. Engr., Topographical Bureau, 209 Montague St., Brooklyn, N. Y.	May 14, 1908
French, James B. Consulting Engineer, Room 1276, Hudson Terminal Bldg., 50 Church St., N. Y.	Oct. 10, 1901
Funk, Harry Edgar. Supt. of Buildings, Transit Development Co., 156 Halsey St., Brooklyn, N. Y.	Apr. 12, 1906
Gelbert, Joseph. Asst. Engr., Brooklyn Rapid Transit Co., 85 Clinton St., Brooklyn, N. Y.	May 12, 1910

	Date of Election
Gill, Stephen J. P. Chief Engineer of Designing, Hudson Structural Steel Co. of N. Y., 425 Sterling Pl., Brooklyn, N. Y.	May 9, 1912
Goodridge, John W. Vice-President, Litchfield Construction Co., 23 Flatbush Ave., Brooklyn, N. Y.	Oct. 11, 1900
Granger, Abbott D. Contracting Engineer, A. D. Granger Co., 15 Park Row, N. Y.	Feb. 4, 1897
Graves, Carleton A. President, Graves Engineering Company, Inc., 35 Pine St., N. Y.	Oct. 8, 1908
A Green, W. Duncan, 4600 Forbes St., Pittsburgh, Pa.	Oct. 9, 1913
Greenfield, Chas. Assistant Engineer, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.	Oct. 14, 1909
Greiff, Peter C. Engineer for Robins Conveying Belt Company, 13 Park Row, N. Y.	Sept. 13, 1917
Griffen, William J. Miller, Daybill & Co., Avenue B and 18th St., N. Y.	Mar. 14, 1912
Griffin, Arthur J. Engineer of Construction, Bureau of Sewers, 215 Montague St., Brooklyn, N. Y.	Nov. 6, 1896
Griffith, Walter R. Asst. Engineer, Bureau of Public Buildings and Offices, Brooklyn, N. Y.	Nov. 6, 1896
Grove, William H. Electrical Draftsman, Edison Electric Ill. Company, Brooklyn, N. Y.	June 24, 1915
Hamilton, John W. Hamilton & Chambers, 29 Broadway, N. Y.	Apr. 14, 1904
Hammond, George T. Engineer of Sewer Design, 1011 Mechanics Bank Bldg., Brooklyn, N. Y.	Oct. 9, 1896
Hammond, John F. Hammond & Sloan, Inc., 16 Exchange Pl., N. Y.	Jan. 7, 1897
Hansen, Samuel J. Engineering Draftsman, Brooklyn Rapid Transit Company, Brooklyn, N. Y.	Sept. 13, 1917
Hardecker, Frank J. Structural Steel Draftsman, Dept. Bridges, N. Y.	Mar. 9, 1911
Hartung, Geo. A. Engineer, Ditmars & Brite, Architects, 111 Fifth Ave., N. Y.	Nov. 10, 1904
Hartley, John E. Supt., P. H. Gill & Sons, Neck Road, Sheepshead Bay, Brooklyn, N. Y.	Jan. 8, 1914
Head, Henry C. Asst. Engineer, Topographical Bureau, Brooklyn, N. Y.	Mar. 10, 1904
Hennessy, Wm. P. Assistant Engineer, Dept. of Water Supply, Gas & Electricity, Brooklyn, N. Y., 2707 Newkirk Ave., Brooklyn, N. Y.	Feb. 12, 1914
Hebert, George W. Asst. Engineer, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.	Jan. 14, 1909
Heghinian, Garabed George. Special Engineer, John Baker, Jr., 265 West St., Brooklyn, N. Y.	Feb. 12, 1903
A Heibel, Walter E., American Blower Company, 141 Broadway, N. Y.	Apr. 13, 1916
Helwig, Alfred. 10th Ave. and 70th St., Brooklyn, N. Y.	Jan. 14, 1904

	Date of Election
Hirsch, Herman D. American Bridge Company, 30 Church St., N. Y.	Oct. 8, 1914
Honeyman, Paul D. Superintendent, New York Telephone Company, 547 Clinton Ave., Brooklyn, N.Y.	Jan. 13, 1916
Horton, John T. 276 Rugby Road, Brooklyn, N. Y.	May 14, 1908
Hough, Calvin C. Asst. Engineer, N. Y. M. Ry. Corp., Room 319, 85 Clinton St., Brooklyn, N. Y.	Feb. 9, 1911
Hough, Frederick L. Assistant Engineer, Edison Elec. Ill. Co., 360 Pearl St., Brooklyn, N. Y.	Jan. 14, 1909
Hughes, Geo. A. N. Y. Edison Co., N. Y.	Apr. 14, 1910
Hunt, Chas. A. 95 Hancock St., Brooklyn, N. Y.	Feb. 10, 1910
Huseman, Joseph C. 838 East 34th St., Brooklyn, N. Y.	Oct. 10, 1912
Hussey, Abram. Supt. of Distribution, Edison Elec. Ill. Co. of Brooklyn, 1045 Sterling Pl., Brooklyn, N. Y.	Feb. 12, 1914
Jackson, George E. Civil Engineer, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.	Jan. 8, 1914
Jennings, J. Edward. 215 Westminster Road, Brooklyn, N. Y.	Oct. 11, 1906
Jones, Forrest S. Chief Engineer, Charles Pfizer & Company, Brooklyn, N. Y.	Sept. 13, 1917
Kamp, Henry. Consulting Engineer, Public Service Commission, First District, N. Y.	Sept. 13, 1917
N Kane, Jasper T. Mechanical Draftsman, Public Service Commission, Room 2428, 120 Broadway, N. Y.	Apr. 10, 1902
Keith, Herbert C. Consulting Engineer, 154 Nassau St., N. Y.	Feb. 8, 1906
Kent, Robert Sayre. Consulting Engineer, 50 Court St., Brooklyn, N. Y.	Nov. 10, 1904
Kirby, I. Henry. Assistant Engineer, Bureau of Sewers, 215 Montague St., Brooklyn, N. Y.	Oct. 12, 1899
Kirgan, John. 594 Eastern Parkway, Brooklyn, N. Y., Supt. for Flinn, O'Rourke Contracting Co.	Feb. 11, 1915
A Kirkham, Henry P. Brooklyn Union Gas Co., 610 6th St., Brooklyn, N. Y.	Feb. 8, 1912
Knight, Geo. H. 3647 Broadway, N. Y.	Apr. 9, 1908
Knight, G. Laurence. Designing Engineer, Edison Elec. Ill. Co. of Brooklyn, N. Y.	Feb. 8, 1906
Knoop, Theodore M. Curtis & Knoop Chemical Works, 275 Water St., N. Y.	Jan. 13, 1916
Koop, Frederick W. Engr. in Charge, Division of Triangulation and Precise Levels, Board of Estimate and Apportionment, Room 1349, Municipal Bldg., N. Y.	Mar. 9, 1905
Krantz, Hubert F. 160 7th St., Brooklyn, N. Y.	Mar. 8, 1906
Krieg, Charles R. Daniel E. Moran, Consulting Engineer.	Mar. 12, 1914
Lane, William C. Brooklyn Union Gas Company. 148 Ridgewood Ave., Brooklyn, N. Y.	July 9, 1914
Langlotz, Charles. Mechanical Superintendent, Brooklyn Cooperage Co., 888 Lincoln Pl., Brooklyn, N. Y.	Apr. 1, 1897

	Date of Election
Langthorn, J. S. Deputy Commissioner, Dept. of Water Supply, Gas & Electricity, 50 Court St., Brooklyn, N. Y.	Oct. 9, 1896
*Lennon, Charles K. In charge Municipal Asphalt Plant of Brooklyn, 214 Prospect Pl., Brooklyn, N. Y......	Apr. 9, 1914
Leopold, Harry D. New York Municipal Railway Company, 85 Clinton St., Brooklyn, N. Y................	May 14, 1914
Lewis, Nelson P. Chief Engineer, Board of Estimate and Apportionment, Municipal Bldg., N. Y..............	June 24, 1897
Lichtenstein, Frederick. Asst. Engr., Public Service Commission, N. Y..................................	Sept. 13, 1917
Llewellyn, Fred. T. Carnegie Steel Co., 30 Church St., N. Y.	Feb. 10, 1910
Lobo, Carlos. Asst. Engineer, Dept. Water Supply, Gas & Electricity, 50 Court St., Brooklyn, N. Y............	May 10, 1906
Lobo, Gustavo, Manager, New York Office, V. M. Braschi Machinery Company, President, Kelvin Engineering Company, 32 Broadway, N. Y.........................	May 11, 1916
Lockwood, Howard T. 373 Park Ave., East Orange, N. J.	Apr. 9, 1908
Long. E. McLean. Consulting Engineer, 13 Park Row, N. Y.	Oct. 13, 1904
Lorenz, Chas. T. Hickey & Schneider, 61 Broadway, N. Y...	Mar. 12, 1914
Macon, William W. Engineering Editor, *The Iron Age*, 239 West 39th St., N. Y...........................	Feb. 9, 1905
MacMahon, William C. Bureau of Highways, Brooklyn, N. Y.	Oct. 11, 1917
MacVeagh, George D. National Meter Company, 258 Monroe St., Brooklyn, N. Y..........................	Mar. 11, 1915
Markey, William A. Assistant Engr., Bureau of Sewers, 1618 Beverley Road, Brooklyn, N. Y................	June 24, 1897
Mathers, Wm. H. Mechanical Engineer, Richard Dudgeon, 82 Broome St., N. Y.........................	Mar. 12, 1914
Mathews, Edw. L. Transit Development Company, 901 Ditmars Ave., Brooklyn, N. Y.....................	Apr. 12, 1917
McColl, Ernest N. Transitman, Bureau of Highways, 50 Court St., Brooklyn, N. Y.......................	Jan. 8, 1903
A McGronan, Chas. J. Asst. Engineer, Board of Water Supply, 451 East 170th St., N. Y.................	Apr. 11, 1912
McInenly, Chas. W. Asst. Engr., Public Service Commission, 154 Nassau St., Room 1812, N. Y...........	Jan. 10, 1907
McKay, John W. Borough Hall, St. George, S. I., N. Y.	Feb. 13, 1908
McMinn, Thomas J. Asst. Secretary, American Society Civil Engrs.	Sept. 13, 1917
Mead, John F. 284 Halsey St., Brooklyn, N. Y.........	Feb. 8, 1906
Meads, Charles. President, Charles Meads & Co., Contractors, 38 Park Row, N. Y.......................	Nov. 10, 1904

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*Died August 4, 1917.

	Date of Election
Meem, James Cowan. Engineer, Frederick L. Cranford, 149 Remsen St., Brooklyn, N. Y.	Oct. 9, 1896
Meissner, Carl A. Metallurgical Engineer, Room 1605, 71 Broadway, N. Y.	Apr. 8, 1915
Meserole, Walter M. Commissioner and Gen. Supt., Atlantic Ave. Improvement, 2513 Atlantic Ave., Brooklyn, N. Y.	Oct. 9, 1896
A Messenger, William H. Asst. Engr., Bureau of Highways, 38 Clinton St., Brooklyn, N. Y.	Oct. 12, 1905
Metcalf, John T. Assistant Engineer, Department of Water Supply, Gas & Electricity, Brooklyn, N. Y.	Jan. 13, 1916
Middleton, John. Civil Engineer and City Surveyor, 2511-2513 Atlantic Ave., Brooklyn, N. Y.	Jan. 7, 1897
Miller, Edwin L. Civil Engr. and City Surveyor, 31 Ocean Parkway, Brooklyn, N. Y.	Jan. 13, 1910
Moore, Fred F. Designing Engineer, Board of Water Supply, N. Y., 129 Prospect Pl., Brooklyn, N. Y.	Mar. 11, 1915
A Moore, Frederic L. Interborough Rapid Transit Company, N. Y.	Jan. 11, 1917
Moore, Henry E. M. H. Treadwell Co., 90 West St., N. Y., 811 Ocean Ave., Brooklyn, N. Y.	Mar. 13, 1913
Moran, Harry P. Chile Exploration Company, 120 Broadway, N. Y.	May 9, 1907
Morris, Harry. Inspector, Dept. of Water Supply, Gas & Elec., Brooklyn, N. Y.	Sept. 13, 1917
Morris, Lardner V. Chief Engr., Bay Ridge and Jamaica Imp., L. I. R. R. Co., L. I. R. R. Station, Jamaica, N. Y.	Apr. 12, 1906
Morris, Wm. Harley. Hennebique Construction Co., 38 Van Buren St., Brooklyn, N. Y.	Apr. 11, 1912
Morrison, Herbert B. Chief Inspector, Engineering Dept., Edison Electric Ill. Co., 360 Pearl St., Brooklyn, N. Y.	May 8, 1913
Morrison, Robert E. Engineer Inspector, Bureau of Highways, 50 Court St., Brooklyn, N. Y.	Nov. 9, 1916
Mosscrop, William A. Mechanical Engineer, 812 Prospect Pl., Brooklyn, N. Y.	Jan. 10, 1901
Mullane, Edward J. In Charge of Engineering Office and Drafting Room, Dept. of Parks, Brooklyn, N. Y.	Oct. 10, 1912
Murphy, Francis P. City Surveyor and Civil Engineer, 177 Montague St., Brooklyn, N. Y.	Oct. 13, 1910
Murray, Thomas J. Inspector, Dept. of Water Supply, Gas & Electricity, Brooklyn, N. Y.	Mar. 9, 1916
Nagel, John. Civil Engineer, 270-52nd St., Brooklyn, N. Y.	May 11, 1911
Broome St., N. Y.	May 12, 1904
Nanry, John J. Engineer for Leroy Tallman, 300 Madison Street, Brooklyn, N. Y.	Oct. 11, 1917
Nelson, James W. Manager, Richard Dudgeon, 82	

		Date of Election
N	**Nexsen, Randolph H.** Asst. Electrical Engr., Public Service Commission, Box 1959, N. Y.	Apr. 14, 1910
	Nicola, Andrew. Contracting Engineer, 50 Church St., N. Y., 174 State St., Brooklyn, N. Y.	Jan. 9, 1913
	Nilon, Martin C. Engineer Inspector, Bureau of Highways, Brooklyn, N. Y.	Sept. 13, 1917
	Noble, Frederick C. Consulting Engineer, 50 Church St., N. Y.	Mar. 9, 1905
	Nosworthy, Arthur. Vice-Pres. and Genl. Mgr., Seaboard Construction Co., 375 Fulton St., Brooklyn, N. Y.	Jan. 12, 1905
	Nowaczek, Frank O. Dept. of Taxes and Assessments, Brooklyn, N. Y.	Nov. 6, 1896
	Orrok, Geo. A. Mechanical Engineer, Willimantic, Conn., R. F. D. No. 2	Nov. 10, 1904
	Owre, Erling. Delano & Aldrich, architects, 128 East 38th St., N. Y.	Sept. 13, 1917
	Oxley, George W. New York Municipal Railway Corporation, 425 45th St., Brooklyn, N. Y.	Jan. 14, 1915
	Palmer, Austin P. 90 West St., N. Y.	Sept. 13, 1917
	Parker, Harry J. R. L. Williams, C. E., Brooklyn, 1440 53rd St., Brooklyn, N. Y.	Oct. 10, 1912
	Payne, Stephen H. 30 Church St., N. Y.	Oct. 14, 1915
N	**Perry, Arthur Irving.** Asst. Engineer, Dept. of Bridges, Municipal Bldg., N. Y.	Nov. 6, 1896
A	**Perry, Francis W.** Asst. Engineer, Dept. of Bridges, 161 Fenimore St., Brooklyn, N. Y.	Oct. 12, 1899
	Pfaendler, Walter. E. W. Bliss Company, 618 11th St., Brooklyn, N. Y.	Apr. 12, 1917
	Philbrick, Joseph. Supt. and General Mgr. of factory, Columbia Chemical Works, Brooklyn, 167 41st St., Brooklyn, N. Y.	Mar. 11, 1909
	Pinco, Chas. N. Assistant Engineer, Dept. of Bridges, 1141 Lexington Ave., N Y.	Jan. 10, 1907
	Pohl, Archibald W. J. President of Pohl-Abbot Construction Co. of 180 Montague St., Brooklyn, N. Y., 1690 Ditmas Ave., Brooklyn, N. Y.	Mar. 13, 1913
	Pollock, Clarence D. Consulting Engineer, 1737 Park Row Bldg., N. Y.	Oct. 9, 1896
	Pond, Frederick H. Assistant Engineer, Board of Water Supply, Room 2234, Municipal Bldg., N. Y.	Oct. 14, 1915
	Provost, Andrew J., Jr. Consulting Engineer, 39 West 38th St., N. Y.	Oct. 9, 1896
	Purdy, Walter M. Room 411, 85 Clinton St., Brooklyn, N. Y.	Jan. 10, 1907
	Quick, Howard P. Consulting and Advisory Engineer, 500-501 City Inv. Bldg., 165 Broadway, N. Y.	May 13, 1909
	Rairden, John J. Prin. Asst. Engr., L. I. R. R, 242 Carlton Ave., Brooklyn, N. Y.	Nov. 8, 1917

		Date of Election
	Rennie, Charles W., Chief Inspector, Department of Water Supply, Gas & Electricity, Brooklyn, N. Y.	Mar. 9, 1916
	Relihan, Edward J. Transitman, Topographical Bureau, 209 Montague St., Brooklyn, N. Y	Jan. 14, 1909
W	Rhett, Albert H. Engineer, Toch Brothers, 320 Fifth Ave., N. Y	Mar. 9, 1916
	Riedel, John C. Assistant Engineer, Bureau of Sewers, Mechanics Bank Bldg., Brooklyn, N. Y	Jan. 9, 1902
	Roberts. Winfred H. Assistant Engineer, Dept. Finance, Municipal Bldg., Manhattan, 4614 11th Ave., Brooklyn, N. Y.	Apr. 13, 1899
	Rogers, John R. 251 Gates Ave., Brooklyn, N. Y	Oct. 11, 1906
	Rosa, Paul. 1123 Broadway, N. Y	May 11, 1911
	Ross, Roderick, Transitman, Department of Water Supply, Gas & Electricity, Brooklyn, N. Y	Mar. 9, 1916
	Russell, Richard Lord. Consulting and Contracting Engineer, 375 Fulton St., Brooklyn, N. Y	Oct. 12, 1905
	Ryan, Joseph A., 162 Woodworth Ave., Yonkers, N. Y.	Feb. 9, 1905
	Sar Vant, Wilbur N. Y. M. C. A., Lebanon, Pa	Oct. 14, 1909
	Schmidt, Herman H. Chief Engineer, Bureau of Highways, 50 Court St., Brooklyn, N. Y	May 10, 1904
	Schmitt, Jacob. 36 South Oxford St., Brooklyn, N. Y.	Feb. 11, 1904
	Scholes, Clinton S. Inspector, N. Y. Municipal Ry. Corp., Brooklyn, N. Y	Nov. 8, 1917
	Seale, Arthur M. Supt. Princeton Machine and Tool Corporation, N. Y	Oct. 11, 1917
N	Seaman, Henry B. Consulting Engineer, Woolworth Bldg., N. Y	Jan. 6, 1898
	Seery, Peter S. Acting Supt., Municipal Asphalt Plant, Brooklyn, N. Y	Sept. 13, 1917
	Sewall, Frank H. Engineering Draftsman, Brooklyn Union Gas Co., 193 Amity St., Brooklyn, N. Y	May 14, 1914
A	Shea, William J. 677 East 21st St., Brooklyn, N. Y.	Jan. 14, 1909
	Sheffield, Oscar. 307 Herkimer St., Brooklyn, N. Y.	Oct. 9, 1913
	Sheridan, John C. Chief Engr., Cranford Co., 52 9th St., Brooklyn, N. Y	Jan. 10, 1901
	Shoemaker, Lynden B. Assistant Engineer, Department of Water Supply, Gas & Electricity, Brooklyn, N. Y.	Feb. 10, 1916
	Shugrue, Michael J. Chief Electrical Draftsman, Edison Elec. Ill. Co., 360 Pearl St., Brooklyn, N. Y	Mar. 13, 1913
	Sinclair, Henry A. Secretary, Treasurer & Electrical Engineer, Tucker Electrical Construction Co., 110 West 30th St., N. Y	Nov. 11, 1909
	Singstad, Ole. Designer, Public Service Commission, 1st District, N. Y	Oct. 12, 1916
A	Sinnott, Francis J. Assistant Engineer, Frederick L. Cranford, Inc., 170 Barbey St., Brooklyn, N. Y.	Oct. 14, 1915

		Date of Election
	Skinner, Frank W. Consulting Engineer, 1318 Woolworth Bldg., N. Y.	May 9, 1912
	Sloan, Frank T. 501 Westminster Road, Brooklyn, N. Y.	Oct. 11, 1906
	Snyder, Chester A. 156 Halsey St., Brooklyn, N. Y.	Feb. 8, 1912
N	**Somner, Clement A.** 4614 11th Ave., Brooklyn, N. Y.	Jan. 11, 1906
	Sprong, Severn D. Electrical Engineer, Edison Electric Ill. Co., 360 Pearl St., Brooklyn, N. Y.	Mar. 8, 1906
	Stangle, Wm. H. Architect, The Barrett Company, 17 Battery Place, N. Y.	Nov. 9, 1911
	Stanley, Nathan W. Assistant Engineer, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.	Jan. 14, 1909
	Steers, Alfred E., Jr. 2694 Bedford Ave., Brooklyn, N. Y.	Oct. 9, 1913
W	**Stein, John B.** Asst. Engineer, Topographical Bureau, 917 Ave. N, Brooklyn, N. Y.	Jan. 8, 1903
	Stephens, Eugene W., 176 Senator St., Brooklyn, N. Y.	May 10, 1917
	Stevens, Charles H. Edison Elec. Ill. Company, 360 Pearl St., Brooklyn, N. Y.	Oct. 8, 1914
W	**Stiles, Linford S.** Construction Engineer, Brooklyn Union Gas Co., 176 Remsen St., Brooklyn, N. Y.	Jan 11, 1912
A	**Storey, Franklin S.** Superintendent, Phoenix Construction Co., 41 Park Row, N. Y.	Mar. 9, 1905
	Stowe, Clarence M. H. C. Stowe Construction Company, Brooklyn, N. Y.	Oct. 11, 1917
	Stowe, Harold C. President, H. C. Stowe Construction Co., 172 So. Oxford St., Brooklyn, N. Y.	Oct. 12, 1911
	Strachan, Joseph. 352 Putnam Ave., Brooklyn, N. Y.	Oct. 9, 1896
	Strachan, Robert C. Bureau of Contract Supervision, Municipal Building, N. Y.	Jan. 12, 1899
	Strong, Marvin W. 39 Stanton St., Union Course, L. I., N. Y.	Oct. 11, 1906
	Tallman, Leroy, Superintendent, Flinn-O'Rourke, Inc., 420 Eastern Parkway, Brooklyn, N. Y.	Jan. 13, 1916
	Taylor, Grant S. Assistant Engineer, 117 Remsen St., Brooklyn, N. Y.	May 11, 1900
	Thatcher, Edwin H. President, John Thatcher & Son, 590 Flatbush Ave., Brooklyn, N. Y.	June 24, 1915
	***Thomson, Samuel F.**, 314 East 21st St., Brooklyn, N. Y.	Feb. 11, 1904
	Tillson, George W. Consulting Engineer to the Borough President, Brooklyn, N. Y.	Oct. 9, 1896
	Towl, Forrest M. President Southern Pipe Line Company, 26 Broadway, N. Y.	Apr. 12, 1917
	Townsend, Charles H. Chief Engineer, Raisler Sprinkler Company, N. Y.	Sept. 13, 1917
	Trafton, Ernest E. Engineer, New York Municipal Railway Corporation, 85 Clinton St., Brooklyn, N. Y.	July 9, 1914

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*Died January 30. 1917.

		Date of Election
Tuttle, Arthur S. Deputy Chief Engineer, Board of Estimate and Apportionment, Municipal Bldg., N. Y.		Oct. 9, 1896
Van Buren, George V. Engineer Inspector, Bureau of Highways, Brooklyn, N. Y.		Mar. 12, 1914
Van Bussum, John D. Asst. Engr., Dept. of Finance, 280 Broadway, N. Y.		May 8, 1902
Van Deusen, Edgar A. Southern Power Company, Charlotte, N. C.		June 24, 1915
Van Norden, Ernest M. Civil Engineer, New York Edison Co., 130 East 15th St., N. Y.		Mar. 10, 1904
Verrill, George A. Construction Dept., Brooklyn Union Gas Company, 1564 East 18th St., Brooklyn, N. Y.		Apr. 12, 1917
Vertefeuille, Joseph A. Department of Water Supply, Gas & Electricity, 37 Briggs Ave., Richmond Hill, N. Y.		Jan. 13, 1916
Very, Edw. D. Consulting Sanitary Engineer, 17 Battery Pl., N. Y.		Feb. 12, 1914
Walsh, Willis J., Sec'y & General Mgr., John D. Walsh, Inc., 397 Hancock St., Brooklyn, N. Y.		May 14, 1914
Ward, Charles R. Chief Engineer, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.		Apr. 13, 1905
Weiderman, George. Pres., Geo. Weiderman Electric Co., 191 Flatbush Ave., Brooklyn, and 35-37 Rose St., N. Y.	Assoc. Corp.	Nov. 9, 1899 Apr. 11, 1912
Weiss, Louis T. Expert in Machine Design and Construction, 1224 Ave. I, Brooklyn, N. Y.		Oct. 10, 1912
Welch, Alden W. Assistant Editor, Engineering News, 10th Ave. and 36th St., N. Y.		Apr. 10, 1913
Wells, James H. Chief Electrical Draftsman, Edison Electric Ill. Company		Sept. 13, 1917
Wells, Walter F. 360 Pearl St., Brooklyn, N. Y.		Jan. 11, 1906
Wendell, Carl A. Chief Engineer, American Ore Reclamation Company, consulting engineer, U. S. Steel Corp.		Sept. 13, 1917
Wepfer, William M. Chief Draftsman, Brooklyn Union Gas Co., 133 Pierson St., Jamaica, N. Y.		Apr. 10, 1913
Wharton, William H. Supt. of Buildings, Brooklyn Rapid Transit Company		Sept. 13, 1917
Wheeler, Harry R. Chief Engineer and Secretary, Henry Steers, Inc., N. Y.		Oct. 14, 1909
Wigtel, Carl. Chief Engineer and Treasurer, Watson, Stillman Company, N. Y.		May 10, 1917
Willgoose, Arthur L. 1464 New York Ave., Brooklyn, N. Y.		Oct. 10, 1912
Williams, George H. Supervising Engineer, Dept. of Water Supply, Gas & Elec., Brooklyn, N. Y.		Sept. 13, 1917
Williams, Richard L. Civil Engineer and City Surveyor, 189 Montague St., Brooklyn, N. Y.		Nov. 6, 1896

	Date of Election
Wilson, Thad. L., Canterbury, Conn.	Feb. 11, 1909
Winslow, George E. Assistant Engineer, D. P. W., 215 Montague St., Brooklyn, N. Y.	Nov. 6, 1896
A **Wolfe, Walter McI.** Asst. Engineer, Frederick L. Cranford, Inc., 149 Remsen St., Brooklyn, N. Y.	Jan. 8, 1914
Wolin, George H. Mechanical draftsman, Edison Electric Ill. Company, Brooklyn, N. Y.	Sept. 13, 1917
Wood, Noble W. Boyd Engineering Co., 11 Broadway, N. Y.	May 6, 1897
Woodcock, Henry W. Civil Engineer and City Surveyor, 263 52nd St., Brooklyn, N. Y.	Mar. 9, 1905
Wooden, Harry S. Chief Draftsman, Dept. Water Supply, Gas & Electricity, Borough of Queens, N. Y.	Oct. 14, 1909
Wynkoop, Hubert S. Electrical Engineer, Dept. of Water Supply, Gas & Electricity, Room 2329 Municipal Bldg., N. Y.	Feb. 4, 1897

ASSOCIATE MEMBERS

Angell, Charles A. Vice-Pres., Cranford Company, 52 9th St., Brooklyn, N. Y.	Apr. 12, 1900
Baxter, Andrew, Jr. Sec'y-Treas., Briggs Bituminous Composition Co., 17 Battery Pl., N. Y.	Mar. 11, 1915
Bennett. Wm. B. Vice-President, Grinden Art Metal Co., 1111 Birch St., Morris Park, L. I.	Mar. 13, 1913
Burr, John W. General Manager, Burr & Houston Co., 84 Calyer St., Brooklyn, N. Y.	Feb. 13, 1902
Chapman, William L. Sec'y, Merritt-Chapman Derrick and Wrecking Co., 17 Battery Pl., N. Y.	Mar. 11, 1915
Cranford, Walter V. President, Cranford Company, 190 Montague St., Brooklyn, N. Y.	Apr. 14, 1898
Cronin, Barth S. General Contractor, 573 Clinton St., Brooklyn, N. Y.	Mar. 9, 1911
Crouse, Charles W. John A. Roebling's Sons Co. of N. Y.	July 9, 1914
Cuozzo, Donato. General Contractor and Expert in Concrete Work, 21 Park Row Bldg., N. Y.	Jan. 12, 1905
Daybill, Alfred. President, Miller, Daybill & Co., Inc., Avenue B and 18th St., N. Y.	Mar. 8, 1906
Drummond, Walter J. President, Beaver Engineering & Construction Company, 215 West 101st St., N. Y.	Mar. 11, 1915
Gallagher, Frank J. General Contractor, 574 Park Pl., Brooklyn, N. Y.	Apr. 9, 1914
Gogarty, Michael J. President, Trinity Contracting Company, Inc., 120 Broadway, N. Y.	May 11, 1916
A **Grinden, William J.** President, Grinden Art Metal Co., Marcy Ave. and Walton St., Brooklyn, N. Y.	June 24, 1897
Guinan, John J. Contractor, 2314 Gravesend Ave., Brooklyn, N. Y.	Oct. 9, 1913

	Date of Election
Hartye, Philip A. Farrell & Hartye, 64 Third Pl., Brooklyn, N. Y.	Mar. 13, 1913
Hewlett, Arthur T. 163 Clymer St., Brooklyn, N. Y.	Apr. 8, 1915
Hiler, Thomas J. 182 82nd St., Brooklyn, N. Y.	Apr. 8, 1915
Horrocks, Edw. E. President, Joshua Horrocks, Inc., 41 Schenectady Ave., Brooklyn, N. Y.	Jan. 8, 1914
Hubbard, Edw. L. 164 Maple St., Brooklyn, N. Y.	Oct. 13, 1910
Huberty, Henry L. President, Werner-Huberty Co., Inc., 50 Court St., Brooklyn, N. Y.	Jan. 13, 1916
Jewell, Harry A. Ball & Jewell, 26 Franklin St., Brooklyn, N. Y.	Mar. 13, 1902
Kelly, Leo E. 189 Montague St., Brooklyn, N. Y.	Oct. 10, 1912
Kiley, Thomas W. Thomas W. Kiley & Co., 57 Grand St., Brooklyn, N. Y.	June 19, 1902
Lott, Erskine H. Superintendent, Flatbush Water Works Company, 579 Ocean Ave., Brooklyn, N. Y.	May 11, 1916
McElraevy, John. Vice-president McElraevy & Hauck Co., 440 Broadway, Brooklyn, N. Y.	Apr. 12,1917
Mead, John J., 592 East 22nd St., Brooklyn, N. Y.	Jan. 11, 1917
Moneypenny, Nelson N. Vice-President, Alberene Stone Co., 223 East 23rd St., N. Y.	Mar. 12, 1903
Ogden, J. Edward. Iron and Steel Merchant, 147 Cedar St., N. Y.	Nov. 12, 1903
Ormond, William C. Contractor, 909 President St., Brooklyn, N. Y.	Oct. 12, 1905
Shevlin, John J. 110 West 34th St., N. Y.	Sept. 13, 1917
Simmons, John S. Vice-President, John Simmons Co., 104-110 Centre St., N. Y.	Nov. 13, 1902
Stagg, John P. Chief Clerk, Brooklyn Union Gas Co.	Jan. 14, 1909
Stedman, Louis A. Assistant Superintendent, Flatbush Water Works Company, 165 Hawthorne St., Brooklyn, N. Y.	May 11, 1916
Stocks, Carl W. Statistician, American Electric Railway Association, N. Y.	Oct. 12, 1917
Williams, Louis W. 460 Washington St., New York City	Oct. 8, 1908

NON-RESIDENT MEMBERS

Anderson, Anders. 118 E Ave. 59, Los Angeles, Cal.	Oct. 11, 1906
Armstrong, John E., 419 Haddon Ave., Camden, N. J.	Oct. 14, 1909
Ball, Laurence A. Structural Engineer, 127 N. Walnut St., East Orange, N. J.	Mar. 14, 1907
Birrell, George V. Transitman and Computer, Topographical Bureau, P. O. Address, 209 Montague St., Brooklyn, N. Y.	Oct. 14, 1909
Blossom, Francis. Partner, Sanderson & Porter, 52 William St., N. Y.	Nov. 6, 1896
Bundy, George L. 37 Wall St., N. Y.	Apr. 11, 1907
Chase, Richard D. 607 Purchase St., New Bedford, Mass.	Jan. 7, 1897

	Date of Election
Conn, Chas. F. Engineer, J. G. White Engineering Corporation, 43 Exchange Pl., N. Y.	Jan. 10, 1901
Cranford, Chas. Boston Development and Sanitary Co., Old South Bldg., Boston, Mass.	Mar. 8, 1906
Cudworth, Frank Grant. Engineer and Architect, c/o Stevens & Cudworth, Construction Engineers, 507-8 Reliance Bldg., Kansas City, Mo.	Feb. 4, 1897
De Groodt, Herv S. Division Engr., Brooklyn Rapid Transit Company, Chatham, N. J.	
Doron, William H. Marden Orth-Hastings, Newark, N. J.	Jan. 14, 1915
Ekstrand, Chas. Mechanical and Electrical Engineer, 429 Sixth St., Brooklyn, N. Y.	Mar. 14, 1901
Entenmann, Paul M., 258 Harvard Blvd., Los Angeles, Cal.	Apr. 11, 1912
Fast, Gustav. Consulting Engineer, Terrace Dale, Towson, Md.	May 11, 1911
A Gibbons, James E. Valley Stream, L. I., N. Y.	Mar. 11, 1909
Graue, Fred, Jr., 452 Grant Ave., Brooklyn, N. Y.	Mar. 12, 1914
Hawxhurst, Harold E. Civil Engineer and Surveyor, Westbury, L. I.	Jan. 14, 1909
Heller, John W. Engineering Contractor, Post Office Building, South Orange, N. J.	May 11, 1905
Hevenor, Herman P. Engel & Hevenor, 220 Broadway, N. Y.	Jan. 14, 1909
Hinck, Frederick W., 1840 East 79th St., Cleveland, O.	
Johnson, Andrew F., 425 Clinton Ave., West Hoboken, N. J.	Jan. 11, 1917
Kennedy, Daniel. President, The Kennedy Valve Mfg. Co., Elmira, N. Y.	May 6, 1907
Kennedy, Matthew E. Secretary, The Kennedy Valve Mfg. Co., Elmira, N. Y.	Feb. 9, 1905
Kessler, Raines. The Terry Steam Turbine Company, Hartford, Conn.	Mar. 13, 1913
Knight, Frank B. Chicago Manager and Engineer, Lidgerwood Mfg. Co., 1917 Fisher Bldg., Chicago, Ill.	May 10, 1906
Legaré, Balie, Peyton. Chief Engineer, United Railroads of San Francisco, Cal.	Apr. 14, 1898
A Lumb, James E. Phoenix Construction Co., P. O. 705 via New York, A. E. F., France	Nov. 22, 1917
A McDonough, John H. Walsh Construction Co., Cleveland, Ohio	Mar. 8, 1917
Newton, Raymond A. Superintendent, Suffolk County Traction Company, Patchogue, N. Y.	Oct. 14, 1915
Nolte, Carl A. Department Water Supply, Gas & Electricity, Bellmore, N. Y.	May 11, 1916
Parliman, Clifford R. Mechanical Engineer, 537 McKean Ave., Donora, Pa.	May 13, 1915

	Date of Election
Rowell, George F., 611 Chestnut St., Philadelphia, Pa...	Nov. 6, 1896
Ruby, Ernest L. Railroad Supplies, Real Estate Trust Building, Philadelphia, Pa	Oct. 14, 1909
N Skehan, Eugene A. Electrical Draftsman, N. Y. Edison Co., 220 East Ridgewood Ave., Ridgewood, N. J.	Oct. 14, 1909
Smith, Leonard B. President, Sussex Limestone Products Corporation, Franklin, N. Y.	July 9, 1914
Spofford, Charles M. Hayward Professor of Civil Engineering, Mass. Institute of Technology, Boston, Mass.	Nov. 9, 1905
Stone, Arthur W. Bedford, Ind	Jan. 9, 1908
Tuttle, Willard S. Garwood Bronze & Iron Works, Garwood, N. J	May 6, 1897
Vail, Frederick N. Civil Engineer, "Oakdene," Stockton, Cal.	Jan. 7, 1897
Von Kroge, Henry A. P. O. Box 222, Negaunee, Mich..	Oct. 11, 1917
Wathey, John W. Chief Engineer, American Concrete Steel Co., Newark, N. J	Nov. 8, 1906
Whipple, George C. Professor of Sanitary Engineering, Harvard University, 6 Berkeley Pl., Cambridge, Mass.	Oct. 13, 1898
White, George L. Transitman, Topographical Bureau, P. O. Address, 209 Montague St., Brooklyn, N. Y.....	Oct. 14, 1909
Whitney, Chas. A. P. O. Address, 2177 Bedford Ave., Brooklyn, N. Y	Nov. 12, 1908
Wolcott, C. Stanton. Engineering Contractor, 284 Main St., Hornell, N. Y	May 11, 1905

TWENTIETH ANNUAL MEETING.

The twentieth annual meeting of the Brooklyn Engineers' Club was called to order at 8.30 o'clock on Thursday evening, December 14, 1916, E. M. Van Norden, President, presiding, Joseph Strachan, Secretary, and a quorum present.

The minutes of the meeting of November 9th were read and approved as read.

Reports of the various committees of the Club were read, and the Annual Report of the Board of Directors to the Club follows:

To the Members of the

BROOKLYN ENGINEERS' CLUB.

Gentlemen:

In accordance with the requirements of the Constitution, the Board of Directors of the Brooklyn Engineers' Club presents herewith its Annual Report.

Meetings.—The papers and informal talks given and the social functions held since the Annual Meeting, December 9th, 1915 are as follows:

December 11th, 1915.—Excursion and inspection of Diesel engine at Brooklyn Navy Yard.

January 6th, 1916.—Informal talk, "Fitting the Turbine to its Job," by Mr. W. J. A. London.

January 13th.—Regular meeting. Paper No. 135.

January 20th.—Subscription Dance at the Club House.

January 27th.—Informal talk, "The Hudson River Crossing of the Catskill Aqueduct." by My Ralph N. Wheeler.

February 3rd.—Ladies Night. Informal talk, "An Engineer's Notes in the Great War Zone," Mr. Frank W. Skinner, member of Brooklyn Engineers' Club.

February 10th.—Regular meeting. Paper No. 136.

February 17th.—Informal talk, "Report of our Delegate to the Second Pan-American Scientific Congress," by Mr. Clarence D. Pollock, member of Brooklyn Engineers' Club.

February 24th.—Informal talks, "Some Theories of Underpinning with Steel-Jacketed Piles," by Mr. John S. Greathead; and "Practical Underpinning Methods in the William Street Sand," by Mr. Edmund A. Prentis, Jr.

March 2nd.—Informal talk, "Efficiency of Compressed Air in Salvage Operations," by Mr. W. W. Wotherspoon.

March 9th.—Regular meeting. Paper No. 137.

March 14th.—Excursion to and inspection of Brooklyn Y. M. C. A. Building.

March 16th.—Informal talk, "Design and Construction of Ordnance," by Mr. A. H. Emery, Jr.

March 23rd.—Informal talk, "Unusual Features of the Hydro-Electric Development of the Colorado River," by Mr. Lamar Lyndon.

March 30th.—Informal talk, "Engineering Fallacies," by Mr. H. de B. Parsons.

April 6th.—Informal talk, "The Construction of the Lexington Avenue Subway Tunnel Under the Harlem River," by Mr. Olaf Hoff.

April 13th.—Regular meeting. Paper No. 138.

April 20th.—Informal talk, "Development of Concrete Machinery; Typical Installation of Concrete Plant," by Mr. A. W. Ransome.

April 25th.—Tenth Annual Smoker at the "Imperial."

April 27th.—Informal talk, "A New Process for Taking Impurities Out of Air or Gas, Whereby Dust, Cinders, Smoke or Gases May Be Separated From Air by Mechanical Means," by Mr. Wm. J. Baldwin.

May 4th.—Informal talk, "Construction of Hill View Reservoir and Placing Concrete Lining," by Mr. Arthur W. Tidd.

May 11th.—Regular meeting. Paper No. 139

May 13th.—Preparedness Parade. Though no effect was made by the club to participate in this occasion as an organization, a very large number of the members paraded in the engineers battalion, which was made up of a large number of engineers in New York City.

May 18th.—Informal talk, "The Coast Defenses of the United States," by Lieut. Col. W. Irving Taylor, C. A. C. and "Field Artillery" by Lieut. Col. Frank H. Hines.

May 25th.—Informal talk, "Putting the Gyro to Work," by Mr. M. B. Lea.

June 3rd.—Excursion to the "Fortifications at Sandy Hook."

June 15th.—"Mandalay" Sail and Dance.

October 12th.—Regular meeting. Paper No. 140.

October 19th.—Informal talk, "Some Engineering Rambles," by Mr. Nathan C. Rockwood.

October 26th.—Informal talk, "The Narrows Siphon of the Catskill Aqueduct," by Mr. John P. Hogan.

November 2nd.—Ladies Night. Informal talk, "The United States and the Citizen," by Capt. Charles Longstreet Poor.

November 9th.—Regular meeting. Paper No. 141.

November 11th.—Excursion to Electric Boat Company and Submarine Base at New London, Conn.

November 16th.—Informal talk. "The History of the Lien Law and the Rights and Remedies of Engineers Thereunder," by Mr. Augustus J. Koehler.

November 23rd.—Informal talk, "Masonry Dam Design and Construction" by Mr. Walter J. Douglas.

December 7th.—Twentieth Annual Dinner at the Hotel Bossert.

December 14th.—Annual Meeting.

House Committee: The House Committee has, as in previous years, worked together with the Entertainment Committee in an endeavor to make the meetings interesting to the members present. The usual collation was served at each of the regular meetings, and musical talent was provided to entertain the members at some of these monthly meetings.

A subscription dance was held at the club on Monday evening, January 24th, and a very pleasant evening was spent by the members and their guests who attended. The proceeds were sufficient to pay all expenses in connection with the dance.

The House Committee has also worked in conjunction with the 1916 Banquet Committee in order to bring about the success of this event of the club.

During the past year a new roof has been placed on the rear extension. The committee wishes the members of the club to assist as much as possible in having the rooms on the top floor rented, as well as the meeting room, thereby increasing the income of the club.

Library Committee: The work of the previous committee has been continued and the following books, pamphlets, etc., bearing on the subject of preparedness, have been added:

Field Service Regulations, U. S. Army, 1914, U. S. War Dept.

On War—Vol. 1, 2, 3—Von Clausewitz.

Regulations for the Army of U. S., 1913, U. S. War Dept.

Technique of Modern Tactics, Majors P. S. Bond and M. J. McDonough.

Report of the National Coast Defence Board, 1905, U. S. War Dept.

Studies in Minor Tactics, 1915, Dept. of Military Art.

Notes on Bridges & Bridging, 1916, Capt. Geo. R. Spaulding.

Notes on Field Fortifications, 1914. Army Field Engineering School.

Tables of Organization, 1914. U. S. War Dept.

Changes Nos. 12 to 35 inc. in Army Regulations, 1914, 1915.

The Military Policy of the U. S. 1912. Bvt. Major Gen. Emory Upton.

Official Bulletin, Oct. 1914, Office Chief of Staff.

Official Bulletin, Dec. 1914 Office Chief of Staff.

Proceedings of U. S. Naval Institute, Sept., 1904.

Proceedings of U. S. Naval Institute Dec., 1904.

Proceedings of U. S. Naval Institute, Mar., 1905.

For convenience all the above publications are listed under the subject of "Preparedness" as well as under their respective titles. Another interesting addition to the library along the same lines is the "International Military Digest" magazine. Other magazines acquired are the "B. R. T. Monthly" and "Russia."

Membership Committee: There have been elected during the year 17 Corporate 5 Associate and 1 Non-resident members.

Entertainment Committee: The work of this committee has been carried along through the year very systematically, and the fine results obtained are evidenced in the list of formal papers and informal Thursday night talks scheduled. In addition to covering satisfactorily all of the technical meetings, a number of lectures to which the ladies were invited were included and engagements of speakers have been carried well into the new year.

Excursion Committee: By invitation of Lieut. Commander E. P. Jessup, U. S. N., a visit to the Brooklyn Navy Yard was made on December 11th, 1915, for the purpose of inspecting the operations of the large Diesel engine about to go into commission on one of the new naval units. The details of workmanship of some of the turbine engines undergoing repairs were noted with much interest by the visiting members.

March 14th.—A number of the members visited the new Y. M. C. A. building on Hanson Place, probably the largest building of its kind in existence.

June 3d, 1915.—The Brooklyn Engineers' Club and Municipal Engineers combined in an excursion to Fort Hancock and the Sandy Hook Proving Grounds adjacent thereto. A total of 328 persons were in attendance, more than half being members of this club and their invited friends. A special train on the N. J. Central R. R. took the party to Sandy Hook and waited on the grounds for the return trip. The day was ideal for the occasion, being clear but not too bright, and all were given a fine opportunity to observe the methods and means of coast defense, including range-finding and fire control, and finally of seeing several shots fired from the 3-inch and 6-inch guns of shells which could plainly be seen as they exploded and distributed their charges of shrapnel over a wide area of the water. The big guns and their mountings were explained by the Army officers, and the trip was a most interesting one. Col. Golden Ruggles, U. S. A., the officer in charge, showed his visitors every hospitality and was cordially thanked for his courtesy in describing the plant and in supplying detailed information in reply to inquiries. Before entering the Government reservation each visitor was obliged to give suitable assurance of his being a citizen of the United States of America.

Committee on Award of the Alfred T. White Prize: The committee, consisting of Past Presidents Wm. T. Donnelly and W. H. Roberts, and Past Director H. W. Woodcock, reported that after frequent consultations they were unable to decide upon the award in time to announce it at the Annual Meeting of the club, and requested further time for consideration of the merits of the papers presented during the year, which extension of time was granted.

Note: The decision of the Committee on Award was read at the meeting of the club on Thursday, January 11, 1917, and in accordance therewith the certificate and fifty dollars in gold was presented to Mr. Alfred H. Rhett for his paper, No. 139, entitled: "The Water-proofing of Structures Subject to Stress from Moving Loads and Temperature Variations," which was read before the club on May 11, 1916.

THE SMOKER.

April 25, 1916.—Our old friends of "The Bunch" took charge of the entertainment for this evening and a large attendance of members and friends greeted them again enthusiastically at the "The Imperial," the scene of many previous successes along these lines. Mr. Frank Martin, the Manager of "The Bunch," was enthusiastically congratulated and thanked for his efforts and each one of his organization was repeatedly encored as new hits were scored. Mr. H. B. Morrison was Chairman of the Smoker Committee for the club, his colleagues being Messrs. H. E. Funk, C. S. Dunphe, P. C. Barney, J. B. Stein, M. J. Shugrue, F. L. Hough, Jr., C. Lobo, C. S. Doron, J. B. Cronin, E. J. Fort, J. C. Riedel, and R. Ankener.

PREPAREDNESS PARADE.

Saturday, May 13, 1916, will be long remembered not only by our own members but by all New York on account of the wonderful parade for the purpose of informing the Congress of the United States then in session that New York City was nearly unanimous in its desire that suitable preparedness should be made by this nation for war. The projectors of the mammoth demonstration discouraged the participation of organizations as such, and general activities were the basis of the divisions; the Engineers of New York took part as the representatives of that profession, and a large number of our members were in line parading all the way from Washington Square up Fifth Avenue to 57th Street where the paraders were dismissed. It was a perfect May day and all New York turned out either to take part in the parade or to watch the long lines of earnest men, each carrying an American flag, marching from early morning, without cessation all day and far into the night. To see all that multitude, largely unaccustomed to military movements, marching with such precision, such firmness of purpose expressed on every face, the sea of flags as one looked far up and down the line was a sight not to be forgotten.

THE JUNE DANCE AND SAIL.

For the June function to which the club annually invites the ladies, the steamer "Mandalay" was again requisitioned but a later date was fixed than formerly in the hope of happening upon a clear, fine evening for the sail and dance.

The Brooklyn Engineers' Club, The Municipal Engineers, the Harvard Engineering Society and the American Society of Mechanical Engineers were associated in this project; the hour of sailing was placed at 7:20 P. M. to avoid the necessity of serving dinner on the boat and an effort made to secure a large representation from each of the above societies.

Dancing was the feature of the occasion, and though the evening was rather chilly, more than six hundred persons braved the weather conditions and between the dancing and the refreshments which were to be found on the lower deck, the evening was passed pleasantly. The landing on the return was made about midnight at the "Battery Landing" from which the party had embarked earlier in the evening. A committee from each of the participating societies took charge and working in complete harmony, the result was as satisfactory as was possible under the adverse atmospheric conditions.

Saturday, November 11th.—A large number of our members accepted the invitation of the American Society of Mechanical Engineers to visit New London, Conn., to inspect the submarine base of the United States Navy at that place, and visit plants near by, engaged in work allied to naval preparedness. A special train of the N. Y., N. H. & H. R. R. left Grand Central depot at 8:36 A. M. on this date, and proceeded to New London, stopping at Bridgeport and New Haven to add to the number of visitors and reaching New London about noon, where all were to dine at the hotels, according to previous arrangement. The number of visitors was too great to be accommodated at one time, and parties not fortunate enough to reach the few tables, proceeded to do some informal visiting.

A place of attraction was the point where the German submarine "Deutschland" was loading in anticipation of a run back to its home port with supplies needed in that country. The guardians of the submarine were not at all hospitable toward the visitors, and the nearest approach possible to the "Deutschland" was by row-boat out past the end of the dock to a point in the stream where a fair view could be obtained, the observers being at all times under the eye of a German guard in the bow of the "Willehad," a German interned vessel, forming one of the fenders from visitors to the submarine.

Later in the day parties visited the New London Boat and Engineering Company's plant on the opposite bank of the Thames, and inspected the founding, finishing and assembling of the various parts of the submarine engines, and made a close inspection of the American submarines, although not permitted by the naval authorities present to board the undersea craft. Returning in groups to New London, the entire party boarded the train for New York about 5:30 P. M. and reached New York about 9:30.

THE ANNUAL DINNER.

The Twentieth Annual Dinner of the Club was held on Thursday, December 7, 1916, at the Hotel Bossert. The plan of separating the Annual Dinner from the regular Annual Meeting was again followed, as in the previous year, and more than two hundred diners were present. The addresses were few in number but excellent in quality, and the war and conditions growing from alignments following the war and treaties in relation to commerce were the main topics discussed. At the guest table, besides the President and Secretary, were Mr. Alfred T. White, Honorary member of the Brooklyn Engineers' Club; Mr. F. C. Henderschott, Executive Secretary of the National Association of Corporation Schools and Manager of the Bureau of Education of the New York Edison Company; Mr. Welding Ring, Chairman of the Executive Committee of the New York Chamber of Commerce; Mr. Elmer A. Sperry, the inventor of the gyroscopic stabilizer for aeroplanes; Mr. Lewis H. Pounds, President of the Borough of Brooklyn, and Mr. E. W. Voorhies, Commissioner of Public Works of Brooklyn. President E. M. Van Norden acted as Toastmaster, preceding the introduction of the speakers with a short address, which follows, upon the theme of

COMMERCIAL OPPORTUNITIES.

There is no task which you impose upon your President that I have approached with greater fear than that of serving as toastmaster at the Annual Dinner. Poor, indeed, would be your mental refreshment had we not been fortunate in securing the services of the distinguished guests who grace this table. During many annual dinners I have sat among you, listening with awe to those, more gifted than I, who have taught and who have amused you from the dais, and little did I believe it were possible for one to pass from the pit to the center of the stage without first acquiring eloquence and a nimble wit. But, be that as it may, I now find myself among the wax-works and I am reminded of the words of the immortal poet, "Fools step in where angels fear to tread."

Following the example of my able predecessor, I have endeavored to choose a theme for the evening, inspired by the spirit of the times and in which we are all intensely interested. I regret that I must be serious to appear natural. Even the real speakers of the evening, with the subjects selected by or thrust upon them, will find it necessary to restrain their customary entertaining humor and their wealth of impossible anecdotes, in order to draw us into an educational atmosphere. I trust, however, that the license accorded every after-dinner speaker to depart from his subject will be fully exercised, so that you may feel that you are attending a regular dinner, in spite of your very temperate indulgence in spirits.

The subject for discussion this evening is "Commercial Opportunties," with special reference, of course, to the conditions during and following the European war. Never before has this subject commanded the public attention now given to it. It makes us conscious of a stimulating patrotism which only a popular national movement could inspire. It is a subject which the close of the war will bring to a climax. The barriers interposed by all the great nations to prevent our commercial growth at the expense of their own will then assume a formidable aspect and we must be prepared to overcome them, not with a view to crushing our competitors, because that is as impossible as it is unwise, but with a well-defined purpose to insure our own commercial expansion.

We must remember that we have profited immensely through the great war, and the blood-stained, emaciated nations of Europe may not feel friendly, or may even entertain hatred toward us, born not alone of envy, but also of resentment of the part we have played.

Our doctrine of humanity may be viewed in a very different light by those who have counted the ships sailing from our shores laden with munitions of war on their destructive mission, passing in ever increasing numbers the gauntlet of hostile submarines. The stand we have taken in this matter as a nation and as individuals, is a humanity paradox, and is nothing more or less than neutrality hypocrisy condoned by international law.

Many of us believe it is all for the best, and it may be. I do not wish to be understood as condemning any means that may bring about the end of military despotism. I believe it is for the best interest of all people. I refer to this matter because much optimism is expressed concerning our commercial opportunities and we are apt to lose sight of the causes now in operation that are working and will continue to work to take from us our fast approaching commercial supremacy.

We must adapt ourselves to the new conditions produced by the war with tact and conservative foresight. "America First" does not mean America only. Future commercial relations of this country can be permanently established only by means that will insure the re-building and growth of the industrial activities of our unfortunate brothers in Europe. The idea, often expressed, that we are in a position to thrust aside with disdain the opinions and criticisms of Europe, is wrong, and to be influenced by such thoughts in our foreign relations and in our legislation may mean the beginning of our commercial decline, when we might, with the unprecedented opportunities before us, be planting the seed of a greater prosperity.

I have spoken of the great nation at war as blood-stained, emaciated and unfortunate. This, surely, they all are, but back of the ephemeral national insanity now controlling them, there is an indomitable spirit which even the unspeakable horrors of war cannot subdue. It is this spirit, driven by necessity and re-inforced with education, industrial skill, astute diplomacy and the most complete military organization ever conceived, with which we must reckon.

Our path to industrial and financial supremacy is not strewn with roses, but on the other hand—what is more important—it is not stained with blood, and with adequate preparation and eternal vigilance it never will be.

There are many reasons for being optimistic. As a guarantee to continued prosperity after the war, our industries, outside of the manufacture of war munitions, will be busy for several years to come with the orders now on their books, and the industrial momentum which we will have acquired by the time the war closes can be safely relied upon to carry us over the period of depression which is likely to follow. Our industries are founded upon natural resources of enormous value which have not been dwarfed and discouraged by war, and which are capable of increased production and of rapid adaptation to abnormal foreign and domestic demands.

If the commercial expansion which seems possible in the near future be realized, even in part, rich opportunities for employment and profit will be found in the increasing demand for raw materials, for power and for skilled and unskilled labor.

Political conditions, neither created nor controlled by this government, have opened an avenue to national wealth and power, more alluring than the dreams of Napoleon; but upon the horizon is the cloud of a greater war in which we must participate, the World Trade War. It may not mean bloodshed, it may not mean the deliberate destruction of property, but that deep-seated, inexplicable hatred, engendered by war, which one nation can hold against another nation, which one race can hold against another race, which one class can hold against another class, will grow like a cancer eating into the very heart of all that is honorable in trade. Time alone is the panacea and Time works slowly.

In the transition period, in which we are now living, the necessity for regulating and training the industrial forces of this country becomes more apparent every day and we should study with care the selection of our leaders upon whom is placed the responsibility for stabilizing the approaching business unrest. Our leaders should not fall into the error of attempting to regulate foreign business alone. While this is very important, we must not neglect our domestic affairs which have already become very much disturbed. Legislative regulation is not unwelcome to the public service corporations, but why confine it almost exclusively to this class. The over-regulated railroads are afraid today to invest a single dollar, and the American people are paying their full share for the shortage of cars, the embargoes and the inefficiency of the depreciated rolling stock.

Regulation of business is a necessary and reasonable function of government, but it should be applied to all business alike if the American public is to enjoy an equitable distribution of the benefits to be derived from the commercial opportunities within our grasp.

Mr. Henderschott stated that one of the great problems before the people of this country today is the proper training of American workmen, as the wealth of the United States lies in the factories and farms, and no nation can rise above the efficiency of its original source of wealth.

He emphasized the importance of educated salesmanship and spoke of the present trend of our educational system in a direction toward that end.

Industrial conditions after the war, in his opinion, was the thought now uppermost in the minds of a vast majority of American businessmen.

The prediction that, if present conditions continue for a while longer, the United States will possess a merchant marine second only to that of Great Britain, was voiced by Mr. Welding Ring. After tracing the development of American shipping from 1812, Mr. Ring showed how it forged ahead following our war with England, until the United States became the leading nation of the world. We began to drop behind, he said, during Civil War times, with the change from wooden to iron bottoms, adding that our navigation laws and lack of equipment for ship building forced us lower down in the scale.

"A change began immediately with the beginning of the present war," said the speaker. "The first effect of this was to interne practically all of German and Austrian shipping. In addition, a large portion of the shipping of England, France and Italy was requisitioned for government purposes. Congress acted promptly, and passed a law enabling our capital to purchase foreign ships and place them under the American flag. Other countries, taking alarm at the large number of their vessels being placed under our flag, passed legislation that prevented any further transfer of tonnage, and buying naturally came to an end. Meanwhile the cost of building ships in other countries advanced, and this brought the cost of foreign shipping almost up to that of ships built in the United States.

"Every shipyard on the Atlantic and Pacific coasts and our Great Lakes is full of orders and unable to accept any new contracts for delivery in less than eighteen months. The amount of tonnage under construction and contracted for is greater than ever before in the history of the United States. Should these conditions continue for one or two years more, the United States will reach the position of second maritime nation in the world.

"Wages in every direction have rapidly advanced on the plea that the wage-earner should participate in the prosperity of the country and also to meet the increased cost of living. Both of these are fair reasons for advances and no one will dispute them. There is, however, great danger that the demands of labor may go too far. The reduction in the hours of labor to an eight-hour day means not only that there will be two hours daily of reduced production, but that costly machinery, the investment value of which is very large, becomes idle for the same period, with the result that there is a great addition to the cost of the article produced."

With wise legislation, Mr. Ring predicted that this country would soon advance to the front as a shipbuilding and ship-owning nation. He cited as reasons our abundance of steel at as low a cost as in any other country, cheaper coal than any other nation, engineering skill of the highest talent in designing steamers and building engines, a continual increase in the number of shipyards and a decided inclination on the part of our merchants and bankers to extend capital to shipping interests.

Borough President Pounds spoke briefly and described in highly complimentary terms the work of the Engineers of Brooklyn with which he has been closely in touch for some years as the directing head of this Borough's activities.

The Annual Meeting of the Club was called to order at 8:30 P. M., Thursday, December 14, 1916, at the Club House, E. M. Van Norden, President, presiding; Joseph Strachan, Secretary, and a quorum present.

Following the reading and approval of the minutes of the previous meeting the annual reports of the various committees were read, followed by the report of the Secretary, summarizing the year's results as to the Club membership and as to its financial condition as follows:

The Secretary reports for the year the resignations of thirteen Corporate and five Non-Resident members; also fourteen Corporate, three Associate and four Non-Resident members dropped for non-payment of dues. The Secretary announces with regret the loss by death of four Corporate members, for each of whom a memoir and portrait will be placed in the proceedings for 1916.

The membership is at present distributed as follows:

Corporate	278
Associate	34
Non-resident	47
Honorary	1
	360

also a waiting list of two Corporate members.

Auditing Committee: In accordance with the requirements of the Constitution, this Committee has audited the books of the Secretary and Treasurer. The books have been found to be correctly kept, and a statement of receipts, expenditures, assets and liabilities of the Club is made a part of this report as follows:

Receipts

Balance in Bank December 1, 1915	$ 648.76
Dues and Initiations	4,055.50
Dinners, Smoker, Excursion, etc	2,034.00
Proceedings, on 1915 account	692.40
Proceedings, sale of various volumes	10.70
Rentals	1,048.97
Badges and Keys	25.25
Subscriptions on various accounts	123.62
Club checks not cashed	2.50
Bank Interest	35.01
	$8,676.71

Expenditures

Taxes—Real Estate	$603.20	
Water	24.00	$ 627.20
Interest on Club Bonds and Mortgage		1,182.92
Fuel		200.00
Lighting		240.10
Insurance on Building		77.70
Insurance on Furniture		16.50
Insurance (Liability)		16.00
Miscellaneous Expenses		337.37
Repairs and Renewals		129.76
Salaries		1,157.00
Printing and Stationery		226.00
Postage		222.10
Typewriting and Stenography		551.50
Proceedings, on 1915 account		842.26
Library		65.25
Dinners, etc.		2,094.91
Badges and Keys		18.00
Balance in Bank December 1, 1916		642.14
On hand, not deposited		30.00
		$8,676.71

FINANCIAL STATEMENT

(December 1, 1916)

Assets

House, 117 Remsen Street	$29,000.00	
Furniture (cost value), less 10 per cent	2,160.00	
Books, periodicals and proceedings (back numbers) estimated	3,500.00	
Outstanding accounts—Dues	415.00	
Rentals	57.00	
On hand, not deposited	30.00	
Balance in Bank	642.14	
		$35,804.14

Liabilities

Mortgage on House, 117 Remsen Street	$18,000.00	
Bonds of the Club	6,000.00	
Excess of Assets over Liabilities	11,804.14	
		$35,804.14

The Board of Directors extends its thanks to the several committees for their work during the year.

Respectfully submitted,

E. M. Van Norden,
G. Laurence Knight,
Joseph Strachan,
H. E. Funk,
Bernt Berger,
Carroll S. Dunphe,
J. S. Langthorn.

The Secretary stated that ballots were ready for distribution among the members present but, as no opposition to the ticket proposed by the Nominating Committee had been voiced since that committee had reported its choice for officers to the November meeting of the Club, it was regularly moved and carried that the Secretary cast one ballot as the vote of the Club for the names presented by the Nominating Committee.

The Secretary reported the ballot cast and the President declared elected as the officers for the year 1917:

President, BERNT BERGER
Vice-President, HARRY E. FUNK
Secretary, JOSEPH STRACHAN
Treasurer, CARROLL S. DUNPHE
Director, WILLIAM J. CONWAY
Director, MICHAEL J. SHUGRUE

Auditing Committee { CARLETON A. GRAVES,
CARLOS LOBO,
HOWARD P. QUICK

The retiring President expressed his appreciation of the loyal attitude of the Club in its support of his efforts during his term of office and the newly elected President assumed the chair.

The prospects for the continuance of the excellent work carried on in the past was discussed by the new President, who pledged untiring zeal to maintain the standards established for which the continued help of the members of the committees was requested.

The meeting then adjourned.

BROOKLYN ENGINEERS' CLUB

No. 135.

PRESERVATIVE OILS FOR THE TREATMENT OF WOOD PAVING BLOCKS.

By A. W. Dow, Mem. B. E. C.

Presented January 13, 1916.

As there have been several excellent papers written on the subject of preservatives for the treating of wood paving blocks during the past few years, I have rather hesitated before selecting this subject for a paper to present to this society. There has, however, been so much controversy of late as to what is the best oil for this purpose that it may be well to analyze the arguments of the contending parties with a view to reconciling their ideas as much as possible without jeopardizing the quality of the resulting preservative oil.

To be able to appreciate the essential qualities that should be possessed by an oil to make it most suitable for the impregnation of wood paving blocks it is necessary to make a study of the defects common to such pavements and endeavor to ascertain the cause and the possible remedy and the relation that the impregnating will bear to these defects. To do this one should be familiar with the structure of the wood in use and understand the properties imparted to it by the impregnation of the oil. · Of course, due consideration must also be given to the economic value of the oil.

The woods used almost exclusively at the present day for the modern treated wood block pavements are cut from different species of pine. They are of even texture with a straight fibre which is easily impregnated. In structure, as you all know, wood is made up of minute cells shaped like elongated cigars, pointed at both ends. The walls of these cells are composed of cellulose, which naturally contain some water which dries out or is absorbed, depending on whether the wood is kept in a dry or wet condition. It is this drying out and reabsorption of water by the cell walls which produces the phenomenon in the wood of expanding and contracting. As wood blocks are laid with the wood fibre vertical and this expansion and contraction is in a line perpendicular to the fibre, the change of volume must be prevented or guarded against if wood is to be used as a paving material.

Wood block pavements when properly manufactured and laid are most desirable and serviceable even under the most trying conditions of traffic and climate, but when improperly manufactured and laid they develop defects that not only tend to shorten their life but make the pavement objectionable. The various defects may be classed as follows:

1st. Expansion of the block, causing a bulging of the pavement, sometimes resulting in the throwing out of the blocks themselves and the displacement of the curb and car tracks;

2nd. Bleeding or oozing of the preservative from the blocks, making the pavement very objectionable as the oil or tarry matter is tracked into stores and dwellings, soiling carpets, rugs and clothing;

3rd. Rotting of the wood, resulting in the rapid breaking up of the blocks under traffic;

4th. Drying out of the preservative from the blocks which in time may render them so porous as to absorb water and swell badly, or, as is often the case, decay from the absorption of germs.

The expansion of wood blocks is without doubt due wholly to the absorption of water by the cell walls of the wood, as above described, and would never occur if the cell walls of the wood were thoroughly waterproofed. It is, therefore, most necessary in selecting the oil for treating the wood that it be capable of waterproofing the blocks so that they will neither lose nor absorb moisture. This waterproofing can be accomplished considerably short of complete saturation of the wood as all that is necessary is to waterproof thoroughly the cell walls and not, as a great many believe, entirely fill the cells themselves.

The cause of the oozing of wood blocks is a disputed question but in my opinion it is largely if not entirely due to pressure on the blocks resulting from their expansion by the absorption of water. This has been practically demonstrated to be the case by experiments conducted a few years ago at one of the creosoting plants. A number of blocks were selected from a charge half of which were laid out loosely on the ground without being in any way confined; the other half of the blocks were laid in an iron frame into which they were tightly clamped. Simple exposure to the hot sun did not cause any bleeding in either set. The two lots of blocks were then wet so as to cause them to swell and it was found that those held tightly in the frame oozed badly, while the others remained perfectly clean, thus showing that the pressure from the expansion of the blocks was the cause of the oozing. Another demonstration which is common to all engineers who are accustomed to the handling of wood blocks is that when blocks are piled loosely on the street before paving no oozing ever takes place no matter how hot the sun nor how much they are exposed to wet and dry weather. As soon as these same blocks have been laid and confined in a street pavement, bad oozing often takes place, especially on a hot day following a warm rain. It is an easy matter to squeeze oil out of a well treated block by subjecting it to pressure in a vise and this method of extracting oil has often been resorted to when it is desired to extract the oil without a solvent for the purpose of examination.

Mr. C. H. Teesdale, of the U. S. Forestry Service, in a very interesting paper before the American Society of Municipal Improvements in 1914, showed that the character of the oil has little to do with the amount of oozing. It is his idea developed from laboratory experiments and a theoretical consideration of treating processes, that the method of impregnating the wood is largely if not entirely responsible for its bleeding. His idea is that if the wood is properly steamed so as to drive the air from the cells before the oil treatment that the blocks will not ooze. There appears to be good ground for his ideas as will be seen by the comparison of two different processes of treating wood. In one process the wood, after being ordinarily air seasoned, is placed directly in the treating cylinder and raised with dry heat to a temperature of about 240°F. The hot oil is then immediately admitted to the cylinder and forced into the blocks under pressure. When the blocks have absorbed the proper amount of oil by gauge measurement the remaining oil in the cylinder is removed and the blocks taken out. In the second process, and the one which is generally approved by Mr. Teasdale, the blocks are first thoroughly heated with live steam to a temperature of about 230°F., after which a vacuum of about 26 inches is drawn on the cylinder, and while the vacuum is still on, hot oil is admitted and forced into the blocks under pressure. When the blocks have absorbed the required amount of oil by gauge measurement the oil in the cylinder is removed.

It can readily be seen that in the first process the cells of the wood after the blocks have come out of the treatment will contain considerable of the air originally in them as there has been nothing in the process which would tend to remove any quantity of it. Of course, some would be removed by expansion from the preliminary dry heat to which the blocks were subjected, but as this is never for any length of time it is doubtful that it penetrated deeply into the block. Further heating of the blocks by the hot oil also would remove a still further small fraction of the air. It is natural to suppose that when the blocks treated by this process are heated the air remaining in the cells will expand and force the oil out to the surface.

In the second process where the blocks are thoroughly steamed the cells all through the wood become heated and more or less full of steam, thus removing a large percentage of the air. Still more air is removed when the blocks are subjected to the vacuum treatment. When the oil is then admitted its progress into the wood is not checked by the presence of air and it can be forced well into the block, and as the co-efficient of expansion of oil caused by heat is very much less than that of air, there will be a much less tendency for the oil to be forced out of the wood when subjected to a rise in temperature.

Mr. Teasdale also showed by experiment that the character of the oil had little to do with the amount of oozing. From practical experience it has been found, as would be expected, that the lighter the oil used in the treatment the more excessive the oozing, all else being equal. Of course, the light oil on the surface of a street is not as objectionable possibly as a sticky tar oil but there has been nothing to show from practical results that a distillate oil oozes any less than the heavy coal tar oils, as has been claimed by some manufacturers, but rather to the contrary. It would appear from this that the excessive oozing of the light oil is the result of improper waterproofing of the block and to the fact that the oil being of less viscosity is more readily forced out of the cells of the wood.

In respect to the influence of the character of the oil on oozing, it is remarkable to what length some manufacturers will go to promote commercial interests. One party claims that the oozing of oil from blocks and their expansion is due entirely to the presence of pitch in the oil. His reason for this belief is that he states that pitch has the property of expanding on both cooling and heating and therefore, if it is contained in the blocks it will cause expansion and oozing under all atmospheric conditions. This argument was actually employed recently before a civic investigation committee as an argument against the use of an oil containing pitch. Still other contractors argue against the use of oils containing coal tar without even giving as much of an explanation for their objection as the above party, but merely make the blank statement that the oozing is the result of the use of an oil containing pitch or the use of an oil that is not manufactured by themselves.

Up to a few years ago the defects in pavements caused by the rotting of wood block were considered unworthy of more than passing comment and what bad cases did develop were thought to be due to insufficient preservative in the wood. It has been considered for a long time that it was only necessary to render the wood waterproof to prevent its rotting. While this is without doubt true, it has been found that the thorough waterproofing of all parts of the wood block by the injection of a preservative oil is a practical impossibility and even though the block may be practically impervious when first manufactured, water manages to work into it by some means or other in the course of time and when this happens germs will easily enter. Of late many bad cases of rotting have developed in wood paving. The City of Charleston, S. C., has a pavement that started rotting nine months after it was laid. The cities of St. Louis, Toledo, Boston, Baltimore, Minneapolis and Indianapolis have had cases of rotting. Toledo has several pavements rotting, one of which will require over 10,000 blocks to put it in perfect condition at the end of its ten year maintenance. Minneapolis, which has the largest yardage of wood block of any city in the country, will have to replace several thousand square yards on account of this defect.

Dr. Hermann von Schrenk, employed by the Southern Pine Manufacturers' Association, has made a very careful investigation of the cause for the rotting of wood block. The results of his investigation to date were made the subject of a very interesting paper at the Dayton meeting of the American Society of Municipal Improvements. From his investigation as well as from personal observations of my own, the following facts have been noted:

In no place where sound wood was used in the first place was the heart wood of the block found to be rotting. The rotting in the sap wood where the preservative used was of high antiseptic value occurred only in patches that had escaped treatment. These patches are evidently the result of improper seasoning followed by improper treatment of the wood and were due to wet patches in sap wood which prevented the entrance of the preservative. Cases of rotting were found in treated sap wood where a non-antiseptic oil had been used for impregnation. A marked example of this was in the Washington street pavement in St. Louis, Mo. The rotting pavements at Charleston, S. C., and Boston, Mass., were also laid with blocks treated with a non-antiseptic oil. It is therefore evident from a study of this defect in wood paving that too great care can not be exercised in the selection of a preservative of high antiseptic value even though it has good water proofing qualities.

Mr. C. P. Winslow in Forest Products Laboratory Circular No. 206 states this point so well that I can not do better than quote from him:

"The value of any creosote as a preservative against decay is fundamentally dependent upon its ability to prevent the development of wood-destroying fungi. This prevention may be accomplished in either of the following ways:

"1. By introducing a material sufficiently poisonous to wood-destroying fungi as to prevent their development.

"2. By introducing a material which will sufficiently exclude moisture or air to reduce the amount of either below that required by the fungi for their development.

"In the past the creosotes which have been successful have generally possessed, at least to some extent, both of these properties; but the first is generally considered the more essential. In recent years, however, there has been some tendency to use materials not markedly antiseptic, but primarily intended to exclude moisture. As yet, however, it has not been completely demonstrated, nor generally accepted that a product can be obtained to fulfill entirely the second requirement."

The loss of preservative from treated wood by both volatilization and absorption has long been considered one of the principal disadvantages in the use of a too light and limpid oil. This defect was recognized in the early history of the industry and is first spoken of by Tidy in his classic paper on the preservation of wood written about 1883 and since then the general tendency has been toward a heavy oil for all preservation work. In 1910, Dr. Alleman, of Swarthmore College and also of the U. S. Dept. of Agriculture, published a pamphlet on the composition of preservative in well preserved timber in which he showed that only the heavier oils were retained by the wood after a long period of time. Since then several bulletins of the Agricultural Department have been published treating on this subject. In 1907 Mr. George W. Tillson presented a paper in which he related his experience with the comparative volatilization of the heavy and light oils, showing that even at 120°F. a light creosote oil, 1.05 specific gravity, lost 72.3% when exposed in a shallow open dish for 50 days, while a heavy preservative oil showed a much less loss. These experiments have been duplicated by the Forest Products Laboratory with like results. Other experiments have been made by the above laboratory showing the volatization of different distillates of coal tar creosote from treated wood.

All this mass of evidence goes to show the necessity for the use of the least volatile oil that it is consistent to obtain. This does not of necessity mean that the oil should be composed entirely of high boiling constituents for it can be made up of a mixture of more volatile materials provided the high boiling heavy constituents are in such excess as to prevent their volatilization. The presence of high boiling materials has the property of preventing the volatilization of lighter constituents. This is in accord with a well established physico-chemical law and is nicely illustrated by an experiment carried out at the Forest Products Laboratory and reported in their circular 188 by Mr. C. H. Teesdale. In this experiment a creosote oil was distilled, after which small logs of wood were impregnated with the different fractions and also with the original oil itself. These logs were 24 inches in length and about 6 inches in diameter, and after having been treated were allowed to stand in the laboratory open piled for over two months at a temperature ranging between 60 and 80° F. They were weighed immediately before and after treatment and at least once a week during the time they were piled in the laboratory. The loss in weight due to the evaporation of the oil obtained by the weekly weighings was calculated in per cent. of the total amount of antiseptic injected. At the end of two months the losses were as shown in table I. A composite of the five fractions was calculated to give an approximation of the loss which might be expected from the creosote from which the five fractions were distilled. This was calculated by multiplying the percentage loss of each fraction by the percentage yield of the fractions in the distillation of the oil and adding these results together. Similar pieces of the wood were treated with a sample of the original creosote and this is found in the last column of the table. In commenting on the results Mr. Teesdale says: "The lighter fractions, as might be expected, lost more than the heavier ones, but the losses for the three first are surprisingly great when compared with the commercial creosote, the latter losing only 5.4 per cent. or about the same as the two heaviest fractions. It might be thought that some of these losses were due to loss of moisture in the wood, but this was found not to be the case. Pieces having a low moisture content often lost as much or more than pieces with a higher moisture content treated with an equal amount of the same fraction."

It can be seen from this the enormous rate of evaporation of the lighter fractions and also how the evaporation of these lighter fractions is retarded by being in solution with the heavier high boiling constituents.

Another very instructive circular, No. 199, along these lines published by the U. S. Forest Products Laboratory gives an account of the examination of preservative oils extracted from two piles after being in use for about 30 years in the Gulf of Mexico. Pile No. 1 was perfectly sound but No.

2 had been attacked particularly at the water line. The oil was extracted from three sections of each pile, the first section being above the water line and the one which would naturally be exposed to the greatest evaporation. Section No. 2 was taken from under water but above the mud line and section No. 3 was taken from the lower end of the pile which had been encased in mud since the pile was placed. The following table, No. 2, giving the amount of creosote found per cubic foot explains itself. An analysis of the oils from the butt of each pile, which having been well protected from evaporation by being encased in the mud and which possibly represented as closely as could be the original oil impregnated into the pile, is given in table No. 3. It can readily be seen that the oil from No. 1 was an ordinary light creosote oil such as is being used at the present day for treating long timber. The oil from No. 2 was a heavy gravity oil with a small percentage of distillate below 315°F., and contained little or no napthalene. The tests carried out on it showed it without doubt to be a water gas tar. It is not necessary even to resort to laboratory experiments to demonstrate the desirability of a heavy oil over a light one for the preservation of wood block. The entire tendency of the industry has been from the light oils to the heavy, as can be seen by a short review.

In the early nineties considerable wood block paving was done in a few of the southern cities and in Indianapolis. In all cases light creosote oil of about 1.03 gravity was used. This light oil was used because of its accessibility, being the material used by the creosoting companies for the impregnation of long timbers and railroad ties. It was observed from these pavements that after they had been done several years they appeared to have lost considerable of their preservative by oozing and evaporation from the surface and that as time advanced the blocks became more porous and absorbent, swelling after each rain. The lesson taught by this experience drove the wood block manufacturers in search of a more stable preservative oil—one that would not so readily evaporate from and soak out of the blocks. With a view to overcoming this defect Bouvier patented a process of treating wood block by which he impregnated them with a mixture of creosote and resin, after which the blocks were given a bath in quicklime, with the belief that the lime would unite with the resin, forming a thick resin soap in the pores of the wood which would prevent the oozing of the oil. This process was tried but was found defective in that the lime penetrated but a short distance into the wood and therefore was ineffective in producing the desired results. The trial of this process, however, had this advantage: it was found that the mixture of resin and creosote oil was very much heavier than the creosote oil itself, and for this reason was better retained by the wood blocks and also that it was much less volatile. It might be said that from this time the success of wood block paving was assured. Many pavements were laid with this creosote resin mixture and have given most excellent results. As the price of resin increased rapidly and it was found that the good results obtained from this mixture were only owing to the thickening of the preservative, other products were tried. Among them was pitch made from water gas tar and from coal tar. Both of these appeared to give results fully equal to that obtained by the resin as far as stability went. This soon led to the use of a mixture of creosote oil and refined coal tar, and it is this product that is now most largely used for the treating of wood paving blocks.

The desirability of heavy non-volatile oils on account of their permanency is being recognized by all branches of the creosote industry, as indicated by specifications and by the numerous articles tending to show the advisability of the use of more permanent oils for wood preserving. Therefore if heavy oils are more desirable for such large timbers as telegraph poles, cross-arms, ties and piles, it must be appreciated how much more necessary it is to treat wood blocks only 2" or 4" thick with a still heavier oil. Oil is also lost from wood block by absorption; that is, the dust and dirt ground into the surface of the pavement by traffic soak up a quantity of oil. This slow absorption which takes place even in cold weather with the lighter oils is naturally in direct proportion to the fluidity of the oil. In pavements laid with blocks treated with light oil this oozing has been known to continue for many years after the pavement was laid.

Having discussed the defects found in wood block paving and the relation of different oils to them, it will be well to look into the characteristics of different grades of oil that are now in use in the industry. In table No. 4 will be found the analysis of several oils typical of the different grades met with in wood block paving at the present day. These oils are as follows:

No. 1. Water gas tar oil.
No. 2. Reilly or Chicago specification oil.
No. 3. Heavy distillate coal tar oil.
No. 4. A. S. M. I. 1915 specification oil.
No. 5. Light distillate coal tar oil.
No. 6. Mixture of medium distillate coal tar oil with refined coke oven tar.
No. 7. Coal tar distillate oil. } Mixture of these two mate-
No. 8. Refined coal tar. } rials produced No. 6.

1. *Water Gas Tar Oil:* This oil is by far the least antiseptic of any used in the impregnation of timber, being only slightly better than crude petroleum in this respect. There are few creosoting firms at the present time using water gas tar alone for treating timber. The parties advocating the use of this material do not claim that it is antiseptic but only that if it is used in sufficient quantities to waterproof the wood it will prevent the development of fungus growth. Their principal argument in favor of its use is its low cost and its ease of impregnation into wood. There have been many thousand square yards of pavement laid with wood block treated with this oil, and in many cases the pavements have given excellent results. It, however, is hardly fair to class it among the coal tar creosotes owing to its low antiseptic value. For pavements on streets of heavy traffic where the blocks are liable to wear out before rotting would set in there is no reason why water gas tar should not be used, either by itself, or, better yet, mixed with proportions of coal tar creosote, but, under the circumstances, it is hardly fair to class it with the more expensive coal tar creosote oils owing to its low antiseptic value.

2. *Reilly or Chicago Specification Oil:* This is only advocated by one group of creosoters in the central west. It is supposed to be a straight distillate oil and is made by distilling off the light fractions from light creosote oil leaving only the high boiling ones. It is a good antiseptic and non-volatile oil and as permanent as any of the heavy distillate oils but no more so than some mixtures of coal tar and medium grade coal tar distillate oil. The only objection that can be found to this oil is its high cost being over twice that of ordinary creosote oil. At a

letting in Cincinnati several years ago the price of the wood block pavement alone treated with this oil averaged 20% higher than where the blocks were treated with an ordinary paving oil. One of the promoters of this oil made the statement last fall that he should say that his pavement would cost about 60c. per square yard more than those where ordinary creosote oil was used. It is claimed for this oil that it is non-volatile and antiseptic and that blocks treated with it will not bleed. Mr. P. C. Reilly, the originator of this material, said in commenting on an article which he read before the American Wood Preservers' Association at New Orleans two years ago: "The adoption of a specification that will demand a creosote oil that will meet in every particular the requirements of the specifications for the Reilly creosoting oil will make a bleeding, swelling or buckling wood block a thing of the past. This character of creosote oil will eliminate a civic nuisance." That there was never the slightest ground for these contentions and that they have been disproven on numbers of occasions since can readily be shown by numerous practical demonstrations. In 1910 the city of Cincinnati awarded contracts for wood block paving to be done with blocks treated by the above parties with the special heavy distillate oil which they advocated. It was claimed that the excessive high price paid for this wood block paving was justifiable as the use of this oil would do away with all past defects in this class of paving. Every pavement laid under this contract where this particular oil was used bled most frightfully and expanded even more than any pavements heretofore laid in that city with blocks manufactured with an oil composed of a solution of refined coal tar in creosote. Numerous photographs were taken by the Bureau of Municipal Research in Cincinnati of pavements laid with blocks impregnated with this oil and they illustrate most accurately the frightful bleeding that took place. (Fig. 1.) The writer saw Rose Hill and Beechwood Avenue shortly after they were laid with blocks treated with this oil. The surface of the pavement had about an inch of sand saturated with the preservative oil which had oozed from the blocks. The pavement had expanded pushing out of place the combination concrete curb and gutter and at places where a pole or cross walk interfered with this expansion the curb was crushed. There was so much bleeding from the blocks on Cross Lane that the asphalt pavement adjoining it was practically

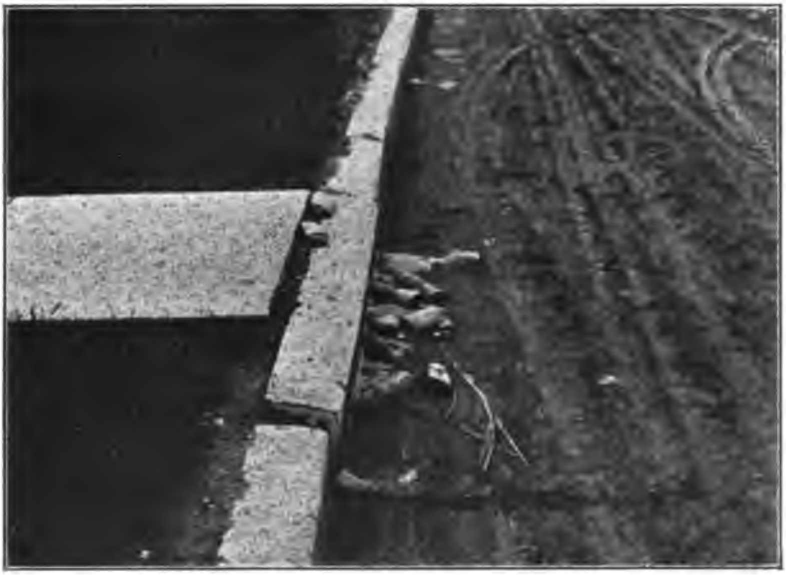

Fig. 135-1. Rosehill and Beechwood Avenues, Cincinnati, O. Wood block pavement treated with Heavy Distillate Chicago Specification Oil. Note thick coating of oily sand on surface of blocks; also pavement has expanded so as to crush curb.

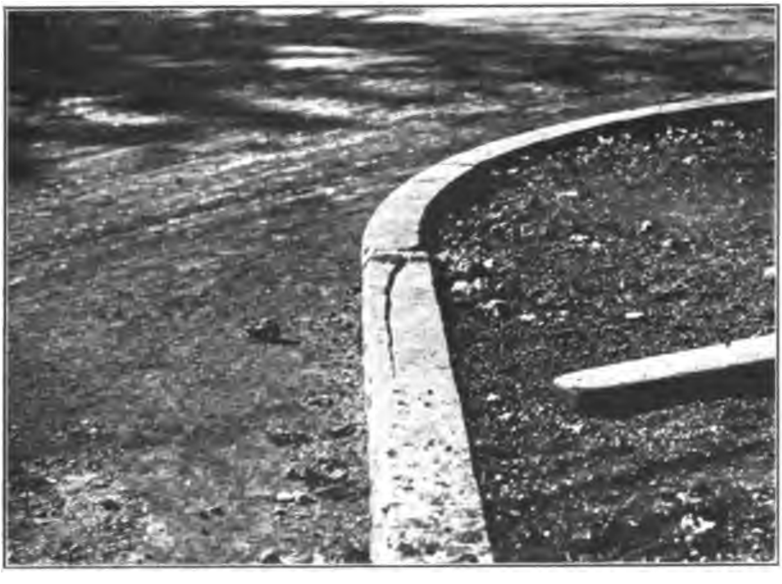

Fig. 135-2. Cross Lane, Cincinnati, O. Wood block pavement treated with Heavy Distillate Chicago Specification Oil. Note thick coating of oily sand on surface of blocks; also pavement has expanded so as to crush curb.

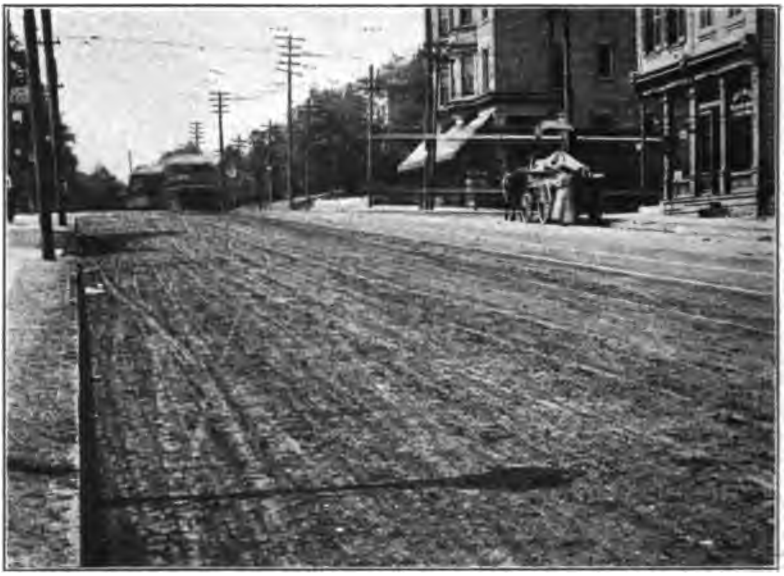

Fig. 135-3. Reading Road, Cincinnati, O., showing granite block pavement covered with caked oil and sand tracked from oozing wood block pavement, which begins at the next intersecting street. Wood block treated with Heavy Distillate Chicago Specification Oil.

ruined by the oil saturated sand which had been tracked on to its surface. (Fig. 2.) On Reading Road, another street treated with these blocks, the oily sand from the surface of the pavement had been tracked on to an adjoining granite pavement, making it appear like a muddy road. (Fig. 3.) Along with this there were numerous places where the blocks had expanded and the pavement heaved. While the oil used in these Cincinnati blocks complies in every way with the Chicago specifications, Mr. Reilly claims that he was not the manufacturer and therefore it is not the same oil which is being used in Chicago under the present specifications, but from a personal examination made by the writer of every pavement laid in this city with blocks manufactured with the above oil he would say that the conditions in Chicago are similar to those in Cincinnati. All pavements examined in Chicago showed that they were bleeding. On a number of these streets property owners complained very much against the bleeding of the blocks and in one case a dry goods store proprietor informed me that he and others had requested the alderman of their district to have the street sprinkled with sand so that the oil would not be tracked into their houses and stores.

In presenting this data to you relative to the Reilly oil it must be thoroughly understood that the writer does not claim that this oil is inferior to many of the heavy oils used on the market. He does claim, however, from his personal examination, that it has no advantages over the other oils and that blocks treated with it are no better and for that reason the high price asked for it is not justifiable on the score of quality.

3. *Heavy Distillate Coal Tar Oil:* This is one of the highest grade distillate oils found on the market. It is typical of the heavy grade oils imported from England and the Continent, and according to the recent report made by Mr. George W. Tillson it is the character of oil required for the impregnation of wood block in practically every city in England. It is classed in the trade as one of the highest grade distillate oils and is suitable for treating all classes of timber. Being a distillate oil, however, it is slightly more volatile than the mixture of distillate and refined coal tar oil.

5. *Light Distillate Coal Tar Oil:* This is a highly antiseptic oil and is much used for treating long timber, such as telegraph poles, piles, railroad ties, etc. Its high volatility and great fluidity, however, make it undesirable for wood block as before explained. The only parties recommending the use of this class of oil are small creosoting firms having limited tank capacity and who are anxious to use the same grade of oil for treating wood blocks as they have on hand for treating heavier grades of timber. The blocks manufactured with this grade of oil ooze much worse and much longer than those treated with heavier grades. This was demonstrated in the experimental pavement laid on Second Avenue, New York, about three years ago. The blocks treated with it give very good results for the first few years but in time so much oil is lost by evaporation and oozing that the blocks become porous and absorb water, thus causing a buckling of the pavement and in some cases a rotting of the blocks.

6. *Mixture of Medium Distillate Coal Tar Oil with Refined Coal Tar:* It is this type of oil which has been most extensively used in wood block paving during the past eight years and in my judgment it has been more successful than any oil used previous to it. Minneapolis, which is the city containing by far the best class of wood block pavements of any in the country, has used this type of oil for the past nine years and it was used by the United States Bureau of Forestry in their experimental pavement in the above city. This oil is made by combining a

medium grade creosote oil (column 7, table 4) with a refined coal tar (column 8, table 4). Last year over eighty per cent. of all the cities in the country laying wood block were specifying this grade of oil. As it contains the lighter distillates of coal tar creosote derived from the creosote oil used in mixing the tar it has a fair antiseptic value and is better in this respect than the very heavy distillate oils. It is of comparatively low volatility because the presence of the heavy coal tar retains the lighter oils as before described. Where pavements laid with blocks treated with this oil are properly laid and manufactured there is little or no oozing, and even in the worst cases this oozing seldom lasts longer than the first year. While this oozing is not as excessive as in the distillate oils it may possibly be somewhat more objectionable to some as it is of a sticky, tarry character. This objection, however, is really only apparent, for when it is tracked on to carpets or into houses it does not spread out and leave a bad spot as is the case with the distillate oils.

In preparing the specifications for the last meeting at Dayton, Ohio, of the American Society of Municipal Improvements, the writer has advocated requirements which would admit the medium and heavy distillate coal tar oils and the coal tar oils made by combining creosote oils and refined coal tars. In drawing up the specifications, however, so as to make it possible to exclude oils with large quantities of coal tar it was necessary to draw the requirements so as to shut out some of the excessively heavy distillate oils. Of course this would not be necessary if two sets of specifications were drawn, one for the distillate oils and the other for the distillate oils and coal tars mixed, but it is the writer's belief that the heavy distillate oils are not of sufficient value to warrant incumbering the specifications with two separate requirements for oil.

TABLE NO. 1.

SHOWING LOSS BY VOLATILIZATION OF DIFFERENT FRACTIONS OF A CREOSOTE OIL.

Fraction No..	Distillation Limits. Degrees C.	Average absorption per cubic foot of wood. Pounds.	Loss per cubic foot of wood. Pounds.	Loss of average absorption. Per cent.
I	0-205	18.13	6.26	34.7
II	205-250	17.46	3.72	21.3
III	250-295	18.89	3.19	15.9
IV	295-320	18.16	1.12	6.2
V	Residue above 320	15.06	.60	4.0
Composite of five fractions (by calculation)	....	.....	....	15.8
Creosote similar to that from which the fractions were distilled	....	20.80	1.13	5.4

TABLE NO. 2.
QUANTITY OF PRESERVATIVE OIL IN TWO PILES AFTER 30 YEARS.

Pile No.	Section No.	Pounds of preservative in treated portion.
1	1	4.5
1	2	15.3
1	3	17.1
2	1	17.0
2	2	16.5
2	3	17.9

TABLE NO. 3.
FRACTIONAL DISTILLATION ON OILS TAKEN FROM SECTION NO. 3, PILES NO. 1 AND NO. 2.

	No. 1	No. 2
Total to 205 C....................	2.5%	0.0%
" " 235 C....................	39.3%	6.0%
" " 255 C....................	43.8%	12.6%
" " 285 C....................	51.5%	30.7%
" " 305 C....................	59.3%	*35.6%
" " 320 C....................	67.2%	**Residue** 64.4%
Residue	32.3%	.....

* Not given above 295 so obtained by difference.

TABLE NO. 4.
CHARACTERISTIC OF VARIOUS PRESERVATIVE OILS OBTAINABLE ON THE MARKET.

	1.	2.	3.	4.	5.	6.	7.	8.
Specific Gravity at 38°C..........	1.12	1.11	1.068	1.089	1.032	1.138	1.050	1.182
Distillation	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
to 170°C.........	....	....	....	....	0.2	....	0.	....
" 200°C.........	....	0.3	0.8	0.9	2.1	trace	trace	0.
" 210°C.........	1.5	1.0	1.6	1.7	5.7	2.1	4.0	1.2
" 235°C.........	8.0	5.4	8.9	15.4	49.1	14.0	30.0	6.0
" 315°C.........	32.0	29.7	53.1	52.4	85.3	38.3	68.0	23.5
" 355°C.........	59.0	43.2	79.6	66.0	94.1	55.9	88.0	34.9

DISCUSSION

MR. G. W. TILLSON, Consulting Engineer, Brooklyn, N. Y.—This is a subject of great interest and probably has been discussed more in the last ten or twelve years than any one other subject, or phase of a subject, that has been presented to municipal engineers. I have been reminded tonight of the many discussions that went on twenty years or so ago of the relative merits of the different kinds of asphalt. I have been through the wood block pavement situation in the west, and know what the wood pavement was in the east late in the sixties. These wood pavements were probably the most pleasing pavements to drive over that there was. Of course, the trouble was that being a perishable material wood did not last long and that was especially true when it was laid in pavements where it would be alternately wet and dry, so that it was a long time before I could convince myself that wood would be a satisfactory pavement material. Wood has been used in Europe much longer than it has here, and successfully; the reason is that in most cases there the traffic is greatest and the wood wears out rather than rots. That, of course, is not always true, but as a rule 95% of the wood pavement laid in Europe will wear out instead of rot. But in this country, take for instance Clinton avenue between Park avenue and Flushing avenue, where the pavement was laid in 1903; after it had been down eleven years, a year or two ago, a yard of it was taken up and exhibited at the Grand Central Palace. The blocks had lost one-quarter of an inch in wear in eleven years. Now if you will allow that a four-inch block can stand a wear of one inch before it becomes too rough for use then you will deduce a pavement life under that traffic, of forty-four years; that, of course, is provided that you will so treat it that it will not decay or rot. That is the whole problem—treat the wood in such a way that it will not decay, then you will get an extremely serviceable pavement. I have not been able to convince myself though that under traffic it would last longer than granite. There are a good many people that believe so, however. The problem is, of course, to treat the wood so that it will not rot. In Europe the wood is treated with a great many different materials—zinc, sulphate of copper, and other preservatives—but the preservers over there have concluded that creosote oil made from coal tar is the best preservative, all things being taken into consideration. Now we all know that this creosote oil is to a certain extent volatile, and to prevent the blocks from decaying you want to keep them stable so that (as said by the author of the paper) they will not expand in wet weather and bulge. You want this oil to be one that will be held in the block for the purpose of keeping it waterproof and keeping it from decaying. The question is what kind of oil will do that best. As the author of the paper has said, after this experimental pavement in Indianapolis had been used there was this scheme of mixing the oil and the resin in order to get a preservative that would not be as volatile as the natural creosote oil, and they got it. The resin itself was not so much of a preservative but it kept the oil in the blocks and so kept them longer from decaying. Now, our first pavements here in Brooklyn, also in Manhattan, were laid by that method, with one exception. When we made the specification, and the specifications were drawn up with a good deal of care and thought, and consultation with the wood preserving people, because they knew something about wood preserving. In order to keep the block from expanding it was thought that it should not absorb more than 3% of water, and in order to prevent that it was thought necessary to put 20 pounds of the mixture into the block. Now, we did not have then facilities for testing at the plant, so we made an additional specification that the blocks should sink in water, and, as the average weight of the yellow pine is about 42 pounds, we knew if the blocks would sink in water they would either have to be of a superior quality of wood or else would have more than 20 pounds of the preservative. Now, I should explain that the specifications did not absolutely require this resin; they said resin or some other suitable waterproofing material. There are now about five thousand yards of wood blocks on the lower end of Washington avenue that were laid without resin and that is the only pavement that was laid previous to the last few years that was not laid with the treatment of 50% resin and 50% creosote oil. Now, as has been said, the price of resin increased and so increased the cost of the treatment, and in Manhattan, I think on lower Broadway, first the specifications were changed so that they required 75% of oil and 25% of resin instead of 50%. That was used for a few years, but about 1908 there was a good deal of discussion as to the advisability of giving up the use of resin altogether as its cost had become so great. A conference was called by appointment from the Board of Estimate and Apportionment, of the Chief Engineer of the Board, the Chief Engineer of the Finance Department, and the Chief Engineers of the Bureaus of Highways of the different boroughs. That resulted in the specifications that, I think, are on record today and still stand as the final specifications of the City, although I do not know how much they are used by all bureaus. That committee held hearings and had every manufacturer of oil, and all people interested in wood block pavements before it. We had before that committee people who advocated the use of water gas tar. The committee felt that if water gas tar would make as good a paving block as coal gas tar and at the same time could be produced at one-half or three-quarters of what the other oil could that they should use it, but from the information it could obtain it did not feel that it was proper to use the water gas tar oil as a general proposition. The result was that it agreed to a specification that would admit a mixture of the coal gas tar oil and the water gas tar oil, of 50%, but not more than 50%. Now that result was obtained by requiring that the fraction distilled should not have a specific gravity greater than 1.02. That seemed to work very well. It was thought advisable to give up the resin and the reason was that if a heavy gravity oil was used it would be sufficient to hold the more volatile parts of the oil in the block and there would be no necessity of using the resin. Now, as I said in the beginning, the use of the treatment is to keep the wood from rotting, primarily. If the wood rots, of course your pavement is going to pieces. So that if you can afford to pay a little more for an oil that will make the pavement last five years longer than one that will make it last twenty years, and if you can also use a treatment that will keep the block in condition for forty years (and in any of our residential streets here the blocks will not wear out in fifty years), then you can afford to pay still more; so that it was thought better to buy possibly a more expensive oil for the reason that it would last longer and give better results and make a more economical pavement in the long run. Of course, if you know just how long each kind of oil will preserve the block and what its cost is you can figure out exactly how high to go and get an economic result.

Mr. Dow has stated a little something about the rotting of the blocks. Now, the first wood block pavement that we laid was in the fall of 1902; that was down on State street. I was looking at that pavement a short time ago and found that there were a few blocks decaying. We laid more the next year, and on this and other streets you can hardly find one single block that is decayed. I have shown a good many people these streets and they have been very much surprised over the fact that we had no expansion joint. I took the City Engineer of Kansas City to Van Buren street and he asked where the expansion joints were. I told him there were none, but he dug around here and there for the cross joints and finally was convinced that there were none. New York City is the only city in the country that does not lay wood block pavement with expansion joints. The success of this pavement without the expansion joint is, in my judgment, because there was required that absorption test of 3%, which I don't think is required anywhere else.

Now, the President suggested that I say something about whether New York City was satisfied with wood block pavements. As the President put the question I shall answer it this way: From my standpoint and from the knowledge I have, the people of New York City are satisfied with the wood block pavements, and, as a whole, they give and have given extremely good satisfaction.

MR. SAMUEL C. THOMPSON, Engineer of Highways, Bronx, N. Y.—My experience with wood block pavements is confined almost entirely to the Bronx, and to the work that has been done there with different kinds of oil, having a different specific gravity.

The first wood block pavement laid in the Bronx was of yellow pine blocks, treated with 50% dead oil of coal tar, and the balance of resin or some similar substance—this was laid in 1903. It stood up very well for a while, until the blocks began to be affected by the water, when it persistently heaved, and required frequent repairs; where it came up against the sheet asphalt pavement, it pushed that pavement all out of shape. The next contract of considerable size was laying a portion of the Southern Boulevard, about 1907. The blocks laid were of black gum, treated wtih a heavy oil, and 25% of resin. The oil had a specific gravity of not less than 1.12, and the blocks were treated until they contained not less than 20 pounds per cubic foot.

The specifications provided for expansion joints along the curb, and across the street, as required. Expansion joints were laid across the street at considerable distances apart. Some of this pavement blew up badly, and required frequent repairs, until the Maintenance Department of Highways eventually placed expansion joints about every 30 feet. The pavement was laid on a concrete foundation with a cement grout joint (1 to 2) and when the work was completed it was a very good job so far as the workmanship was concerned. One difficulty that was experienced was in the size of the blocks which were specified as 3" x 3", and as a result, the block layers laid many of the blocks with the fibres parallel to the cross-section of the street, so that it was necessary to make a very careful inspection, and many thousand blocks had to be changed so as to bring the fibres of same vertical to the roadway.

To my mind, this street was not a thoroughfare which legitimately called for a wood block pavement, as at the time that the pavement was laid the traffic on the street was light.

Various contracts were completed after this time with wood block, almost entirely of hard pine, and some of them were laid with a bituminous filler instead of a cement grout filler. These streets have kept in very good shape, but it was certainly true that people who lived in the neighborhood made remarks about the administration under which the work was laid that would not look well in print.

The last work laid in the borough was a hard pine block on a concrete foundation, with a sand filler, and up to the present time it has given good service.

There was no opportunity for making laboratory tests on the oils submitted, as no laboratory for this purpose existed in the borough, and when it was deemed advisable to make laboratory tests they were made either by the Central Testing Laboratory or based upon such experiments as could be verified elsewhere.

As a whole, the wood block pavement in the Bronx has proven satisfactory, and the actual wear on the same has been trifling.

I have not had opportunity to make careful examinations of the blocks as to whether there has been any decay, but from a casual observation I have not noticed any indication of rot in the block itself.

Discussion by COL. J. W. HOWARD, Consulting Engineer on Pavements, New York City.—We have been benefited by the paper just read by Mr. Dow and it is right he did not mean to advocate a "compromise" specification for oil, but he has undertaken to suggest a comprehensive and embracing specification such as will provide for the use of all wood preservative oils for impregnating wood paving blocks which have been successful in actual work.

The speaker calls attention to the fact, as stated by Dr. von Schrenk at the Convention of the Am. Soc. Municipal Improvements, October, 1915, at Dayton, Ohio, that the "successful preservation against decay of wood paving blocks depends as much if not more on the thorough seasoning, method of treatment and impregnation of the wood, than upon the precise qualities of the light or heavy oils used, and especially that a thorough treatment of the wood requires, as far as physically possible, the absence of water in the wood when being impregnated with the oil, particularly the sap-wood in contradistinction to the heart and resinous wood in each block of wood."

The species and quality of the wood itself are very important. Where the traffic is heavy and numerous, wood pavement wears out before there is time for it to rot out. Where traffic is light the reverse is true.

Wood pavements have their limited but suitable place, especially on some business thoroughfares and their equivalent in large cities; while other pavements of granite, asphalt, brick, etc., are generally more suitable, efficient and economic, each in its proper place, on the majority of streets of cities. During the past thirty years the examination by the speaker of wood pavement specifications and wood pavements constructed according to them in many cities of Europe and America have convinced him that a specification for wood pavement should be a standard of enumerated qualities which all the materials, including the preservative oil, must meet to be good for the purpose; and not be a direct or indirect description in technical language of any special brand or product to the exclusion of others known by experience to be good, durable and economic.

Many engineers know of specifications descriptive of a tar-product or tar-oil compound for treatment of wood paving blocks, which has appeared in some cities and which is a description by inserted, alleged tests, put there to practically control or limit the special tar-product or compound, so that it must be a pitch or tar-containing oil such as to exclude from competition and use the long established and used standard distillate creosote oils. This exclusion is accomplished by specifying a specific gravity of 1.08 or heavier combined with a requirement that the total distillates up to 315. C. shall not exceed 40% and sometimes 50%, and by the insertion of gravities for distillates, also by the omission of any requirement as to whether or not the remaining residue, after this distillation, shall be soft at ordinary room temperature of 77. F. It is well known that good distillate creosote oils yield as high as 85% of total distillates up to 315. C. and as much as 95% up to 355. C., and that such oils have specific gravities at 38. C. both below and above 1.08, and have soft residues.

A set of specification tests for wood preservatives should be as few and simple as possible, so as to be made by any chemist and understood by city engineers not chemists. The specifications should state that the preservative used must be insoluble in water; able to thoroughly impregnate the wood to thereby exclude water from the portion of the wood cells subject to decay and to prevent swelling of the wood blocks and buckling of the pavement. The preservative must be antiseptic and germicidal by containing at least 10% of crystalizable naphthalene. It must contain at least 15% of anthracene oil which is stable and permanent under all conditoins of weather.

The bases of supply of raw materials from which most good distillate creosote oils are manufactured are the crude coal-tars, called gas-tars, from gas plants, and coke oven tars, which are a by-product from the manufacture of coke. Water-gas-tars are the by-products of gas plants making hydrogen water-gas, enriched with carbon from petroleum and otherwise. Water-gas-tars have begun to be successfully used for making a distillate preservative oil which gives promise of success,especially if some napthalene containing distillate or other suitable antiseptic is added.

The speaker believes that the true authorities and official records, not commercially inspired, of Germany, England, France and the United States, and his periodical examinations of typical wood pavements during many years in many cities, show that the best preservatives for wood are those made by distilling tars, and are not simply tar products or compounds of oils and pitch, which are not distillates. The U. S. Forestry Service Circular 206, page 9, shows creosote oils to be all distillates, stating: "The general process of manufacture is similar in all cases. The tar is distilled in a metal retort or still and the vapors are condensed and collected. Those distillates which are heavier than water form the true creosotes used in wood preservation. The temperatures at which the creosotes are obtained vary greatly, but generally lie between about 200° and 360° C."

The following is an excellent specification for creosote oil, adopted by the American Railway Engineering Association after recommendation by Committee XVII on wood preservation—Messrs. Stimson, Bowser, von Schrenk and nine other members, as follows:

"*Grade* 1 *Coal Tar Creosote,* referred to also as Maintenance-of-Way Oil No. 1. The oil used shall be the best obtainable grade of coal-tar creosote; that is, it shall be a pure product obtained from coal-gas-tar or coke-oven-tar and shall be free from any tar, including coal-gas-tar and coke-oven-tar, oil, or residue obtained from petroleum or any other source; it shall be completely liquid at thirty-eight (38) degrees centigrade and shall be free from suspended matter; the specific gravity of the oil at thirty-eight (38) degrees centigrade shall be at least 1.03. When distilled by the common method—that is, using an eight (8) ounce retort, asbestos covered, with standard thermometer, bulb one-half (½) inch above the surface of the oil—the creosote, calculated on the basis of the dry oil shall give no distillate below two hundred (200) degrees centigrade, not more than five (5) per cent. below two hundred and ten (210) degrees centigrade, not more than twenty-five (25) per cent. below two hundred and thirty-five (235) degrees centigrade, and the residue above three hundred and fifty-five (355) degrees centigrade, if it exceeds five (5) per cent. in quantity, shall be soft. The oil shall not contain more than three (3) per cent. water."

Also the Committee recommended: "Whenever possible only Grade 1 Coal Tar Creosote should be used, and under no circumstances should coal tar be added to creosote of this grade." and in Vol 15, page 680, Proceedings Am. Rwy. Engineering Assn. Appendix A, by Dr. von Schrenk and Mr. Kammerer, state: "The writers firmly believe that the best results with creosoting will always be obtained by the use of oil equivalent to the Am. Ry. Eng. Assn. No. 1 oil. * * * The practice which has come about in various quarters of selling creosote oil mixed with coal-tar as a No. 1 specification oil, should be stopped; and where No. 1 specification is called for, that the specification for such oil, as printed, in the Manual, be rigidly enforced."

The following illustrate good types of distillate creosote oils which have been long and successfully used for preserving wood paving blocks. The specific gravities, while not the determining factor in the quality of the oils, are as follows, being taken at 38.C. (100.F.), American in general use 1.034; another American used at Chicago, Springfield, Ohio, and elsewhere in 1914-15, 1.109; the two having total distillates up to 355.C. (671.F.) of 91% and 70% respectively, and having residues left, after distillation test, which are soft at 77.F. and of dark amber color and not hard, brittle pitch. German creosote oil, sp. gr. 1.064; distillates up to 355.C. 80%, leaving soft residue. English creosote oil, sp. gr. 1.044; distillates to 355.C. 90%, residue soft. It is interesting to note, for comparison, the pitch mixture or pitch-containing oil, not a distillate, which within comparatively few years has been introduced into some cities in the United States and not as good as creosote oils, that it has a specific gravity 1.115, distillates up to 355.C from 35% to 61%, according to its heavy pitch content, and that the residue remaining after distillation is hard, stiff, brittle pitch; also that this pitch tar oil, called "coal tar product," has 3.1% of matter not soluble in benzol, while genuine creosote oils have less than 1% thus insoluble.

It is not necessary to describe the processes of treating or impregnating wood with creosote oil, because, beginning with the Bethel process of wood preservation invented in 1838, the processes of all are described in several standard works, including the processes of Labrot, Lowry, Card, Burnett and Rueping.

In regard to the quantity of any one of the high grades of true distillate creosote oils necessary to be used for preservation of wood paving blocks, there has been a tendency to require too much, possibly originating from producers of oils trying to market as much as possible; also to try to overcome defects in wood paving blocks due to imperfect seasoning, preparation and treatment of blocks. An excess of oil weakens the mechanical and therefore the wearing strength of wood paving blocks. The writer believes that experience has shown that 14 lbs. and sometimes even less, of good distillate creosote oil per cubic foot of dry wood is ample. It being understood that the wood is to be properly prepared and treated with the thoroughly impregnating oil, which can be done with distillate creosote oils used in small quantities at proper temperatures, vacuums and pressures at wood preserving plants. Blocks thus manufactured and treated practically eliminate the bleeding and oozing of oil which is such an objection to wood pavements. Citizens want clean, handsome street pavements from the start and not pitch-oozing, dirty ones which are not necessary where wood pavements have been constructed under proper specifications.

The speaker advises that a specification should require:—Distillate creosote oil which shall be waterproof, contain at least 10% of crystallizable naphthalene and at least 15% of anthracene oil and must be above 1.03 sp. gr. at 38.C. (100.F.), contain less than 1% of suspended or other matter insoluble in warm benzol; no lower boiling or volatile fractions distilling off up to 150.C. (302.F.); practically no appreciable distillate below 200.C. (392.F.), and the residue remaining after distilling up to 315.C. (600.F.), when cooled to 25.C. (77.F.) shall be between yellow amber and very dark brown color and so soft as to be easily indented with the finger.

A specification for wood block paving should be such as to assure lowest possible cost by permitting competition from all sources of supply of creosoted wood paving blocks meeting the comprehensive, inclusive or standard open specification such as the writer has tried to indicate. The excellent paper by Mr. Dow does not seem to have presented a set of tests or specifications for creosote oil or other preservative sufficiently broad to include all those which practice has shown give good service in wood block pavements. No specifications should exclude wood pavements which have proven themselves to be durable, efficient, successful and in good condition in actual use for a period of ten or more years, under severe climatic conditions and heavy, numerous traffic. A broad, safe, open, single, comprehensive standard specification is the best and permits the use of all such wood pavements and all creosote oils which have been successful.

BROOKLYN ENGINEERS' CLUB

NO. 136

THE EAST NEW YORK TUNNEL
A PART OF THE BAY RIDGE IMPROVEMENT OF THE LONG ISLAND RAILROAD.

By JAMES B. FRENCH, Mem. B. E. C.
Presented February 10, 1916.

Introductory.

The Bay Ridge Improvement is the name applied to the elimination of grade crossings, the general improvement of grades and the enlargement of track facilities on the line of the Long Island Railroad Company running from the proposed new freight terminal on Upper New York Bay, at the foot of Sixty-fifth Street, Bay Ridge, through the southern and East New York sections of the Borough of Brooklyn to the Queens Borough Line near Evergreen Cemetery; and also on the line from Manhattan Beach to Manhattan Beach Junction, near the intersection of Avenue I and East Sixteenth Street. (See Fig. No. 1.)

In conjunction with the car-float ferry from the Pennsylvania Railroad freight terminal at Greenville, N. J., the proposed new transfer bridges at Bay Ridge, the New York Connecting Railway, and the new Hell Gate Bridge over the East River, the main portion of these improved facilities will form a link in the new freight trunk line from Philadelphia to Boston, and a connection between the Pennsylvania and the New York, New Haven & Hartford Railroad systems. All of the work of the Bay Ridge Improvement has been executed under the authority and supervision of the Brooklyn Grade Crossing Commission, a board appointed by the Mayor of New York City, in accordance with the provisions of a law passed by the State Legislature in the spring of 1903.

The work was started in 1904, has been continuously under way since that time, and different parts of it have already been described in papers read before this club. With the completion of the East New York tunnel, which is the subject of the present paper, practically the only work remaining to be done is the terminal yard at the foot of Sixty-fifth Street, which properly includes the Third Avenue Bridge and a group of four transfer or float bridges.

THE EAST NEW YORK TUNNEL.

General Description.

The East New York Tunnel begins a few feet south of East New York Avenue, near its intersection with Vesta Avenue, and extends to a point near the intersection of Evergreen Avenue and Pilling Street. (See Fig. No. 2.) It has been built to accommodate four railroad tracks, has a total length of 3,434 feet, or five-eighths of a mile, an outside width of 69 feet 8 inches, and a maximum depth below the surface of the ground of 54 feet. Its construction has involved the excavation of 374,600 cubic yards of material, the placing of 83,200 cubic yards of concrete and of 2,290 tons of steel reinforcement, and a total expenditure in money of about $1,100,000. By its construction the railroad company obtains four tracks in place of two, a uniform gradient of 0.7 per cent. in place of a broken grade line having stretches of grade as high as 3 per cent. in a northerly and 2½ per cent. in a southerly direction. The new tracks have a length only about 85 feet shorter than the old, but have much improved alignment and a rise and fall of something over 47 feet is eliminated. (See Fig. No. 2.)

The most important result of the construction of this tunnel, however, is the elimination of some 11 grade crossings, including such important thoroughfares as East New York Avenue, Atlantic Avenue, Fulton Street, Broadway, Eastern Parkway, and Bushwick Avenue.

At Atlantic Avenue the old tracks not only occupied the surface of the street, but crossed at grade the two tracks of the Atlantic Division of the Long Island Railroad, which are undoubtedly the busiest and most important passenger lines in use by that company; and at Fulton Street and Broadway important trolley lines were crossed.

Design and Detailed Description.

For the purpose of discussing the design and describing the tunnel structure in detail the work naturally divides itself into three parts:

First. The regular four-track section making up about nine-tenths of the length of the tunnel.

Second. The section from the south portal to the north side

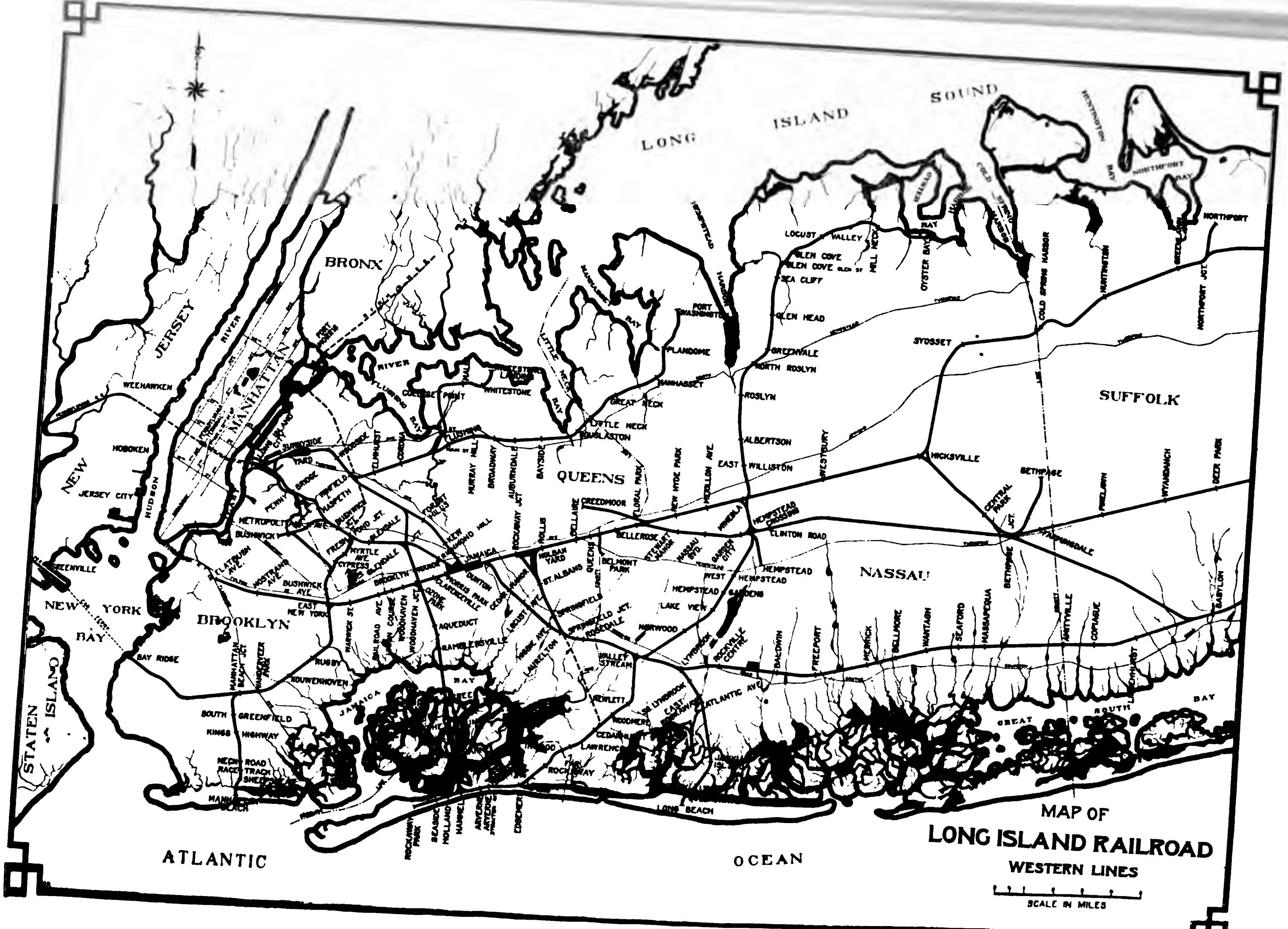
MAP OF
LONG ISLAND RAILROAD
WESTERN LINES
SCALE IN MILES
LONG ISLAND SOUND
ATLANTIC OCEAN
SUFFOLK
NASSAU
QUEENS
BROOKLYN
BRONX
MANHATTAN
NEW JERSEY
STATEN ISLAND
NEW YORK BAY
HUDSON
GREAT SOUTH BAY
JAMAICA BAY
NORTHPORT
NORTHPORT JCT.
GREENLAWN
HUNTINGTON
COLD SPRING HARBOR
SYOSSET
OYSTER BAY
HILL NECK
LOCUST VALLEY
GLEN COVE
SEA CLIFF
GLEN HEAD
GREENVALE
NORTH ROSLYN
ROSLYN
ALBERTSON
EAST WILLISTON
WESTBURY
HICKSVILLE
BETHPAGE
CENTRAL PARK
BETHPAGE JCT.
FARMINGDALE
PINELAWN
WYANDANCH
DEER PARK
BABYLON
LINDENHURST
COPIAGUE
AMITYVILLE
MASSAPEQUA
SEAFORD
WANTAGH
BELLMORE
MERRICK
FREEPORT
BALDWIN
ROCKVILLE CENTRE
LYNBROOK
HEMPSTEAD
WEST HEMPSTEAD
HEMPSTEAD GARDENS
HEMPSTEAD CROSSING
CLINTON ROAD
GARDEN CITY
NASSAU BLVD.
STEWART MANOR
BELLEROSE
MINEOLA
MINEOLA AVE.
NEW HYDE PARK
FLORAL PARK
CREEDMOOR
BELLAIRE
HOLLIS
QUEENS
BELMONT PARK
HOLBAN YARD
ST. ALBANS
SPRINGFIELD
SPRINGFIELD JCT.
ROSEDALE
LAKE VIEW
NORWOOD
VALLEY STREAM
HEWLETT
WOODMERE
CEDARHURST
LAWRENCE
FAR ROCKAWAY
EAST ROCKAWAY
OCEANSIDE
ATLANTIC AVE.
LONG BEACH
PORT WASHINGTON
PLANDOME
MANHASSET
GREAT NECK
LITTLE NECK
DOUGLASTON
BAYSIDE
AUBURNDALE
BROADWAY
MURRAY HILL
FLUSHING
WHITESTONE
COLLEGE POINT
CORONA
ELMHURST
WOODSIDE
SUNNYSIDE
LONG ISLAND CITY
YARD
PENNY BRIDGE
HAYFIELD
MASPETH
BUSHWICK JCT.
FRESH POND JCT.
GLENDALE
FOREST HILLS
KEW
RICHMOND HILL
JAMAICA
DUNTON
MORRIS PARK
CLARENCEVILLE
ROCKAWAY JCT.
LOCUST AVE.
LAURELTON
OZONE PARK
WOODHAVEN JCT.
WOODHAVEN
UNION COURSE
RAILROAD AVE.
WARWICK ST.
EAST NEW YORK
AQUEDUCT
RAMBLERSVILLE
CYPRESS AVE.
MYRTLE AVE.
BUSHWICK AVE.
METROPOLITAN AVE.
BUSHWICK
FLATBUSH AVE.
NOSTRAND AVE.
RUGBY
VANDERVEER PARK
MANHATTAN BEACH JCT.
NOUWENHOVEN
SOUTH GREENFIELD
KINGS HIGHWAY
NECK ROAD
RACE TRACK
SHEEPSHEAD BAY
MANHATTAN BEACH
BAY RIDGE
ROCKAWAY PARK
SEASIDE
HOLLAND
HAMMELS
ARVERNE
EDGEMERE
WEEHAWKEN
HOBOKEN
JERSEY CITY
GREENVILLE
PORT MORRIS

Fig. 136-1.

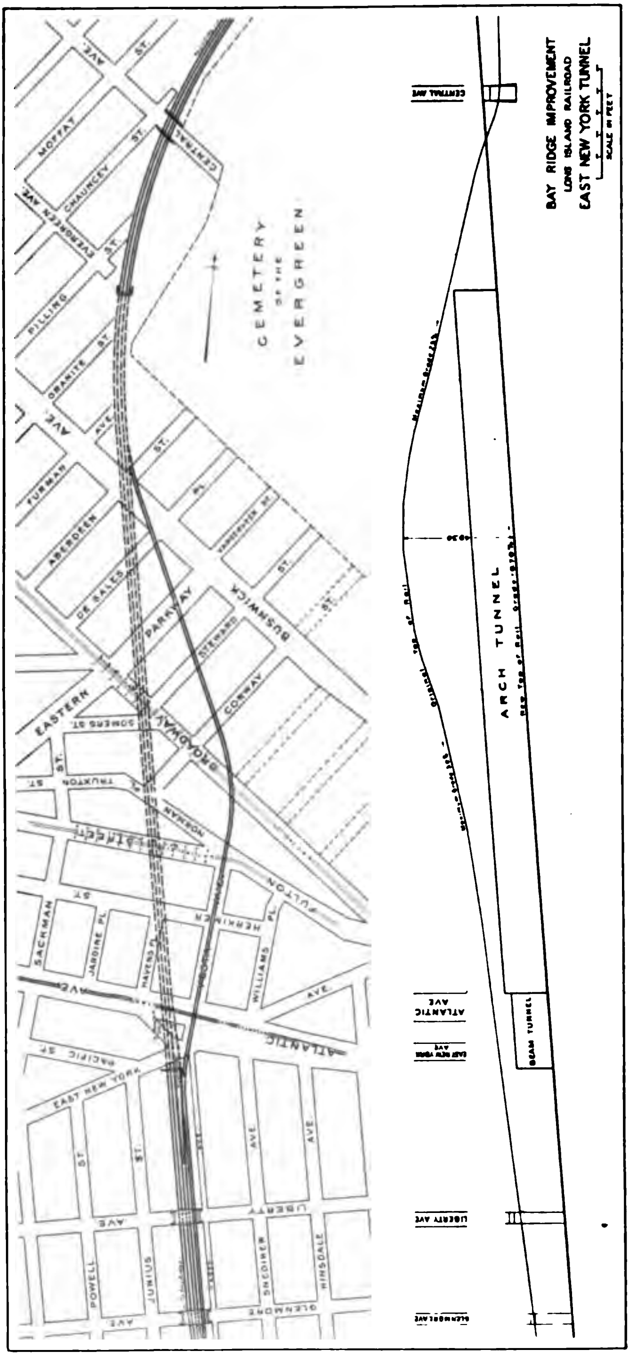
BAY RIDGE IMPROVEMENT
LONG ISLAND RAILROAD
EAST NEW YORK TUNNEL
SCALE IN FEET
ARCH TUNNEL
BEAM TUNNEL
CENTRAL AVE
ATLANTIC AVE
EAST NEW YORK AVE
LIBERTY AVE
GLENMORE AVE
CEMETERY OF THE EVERGREEN
MOFFAT ST.
CHAUNCEY ST.
EVERGREEN AVE
PILLING ST.
GRANITE ST.
FURMAN AVE.
ABERDEEN ST.
DE SALES PL.
EASTERN PARKWAY
BUSHWICK AVE
STEWART ST.
CONWAY ST.
BROADWAY
SOMERS ST.
TRUXTON ST.
FULTON ST.
SACKMAN ST.
JARDINE PL.
HAVENS PL.
HERKIMER PL.
WILLIAMS PL.
PACIFIC ST.
POWELL ST.
JUNIUS ST.
SNEDIKER AVE.
HINSDALE ST.

Fig. 136-2.

of Atlantic Avenue within which provision is made for a station platform, stairway and elevator to handle passengers, baggage and express matter, and within which three 48-inch water mains and the Atlantic Division tracks of the Long Island Railroad have to be carried over the tunnel.

Third. The special construction for the permanent support of the elevated railroad structures at Fulton Street and Broadway.

Taking up these sections in order the first, or regular tunnel section (see Fig. No. 3) is designed to provide four single-track tubes, each having a clear inside width of 14 feet and a clear height above top of rail of 17 feet 6 inches, dimensions sufficient to amply accommodate the largest railroad equipment. At intervals of about 20 feet refuge niches are provided, 3 feet wide and 1 foot 9 inches deep, large enough to accommodate at least two men. In each side wall 12 vitrified single-duct conduits are provided for electric cables and splicing chambers are located at intervals of 400 feet. No cables have been installed at the present time and steam locomotives are alone used for hauling trains; but the tunnel structure as built will permit the installation of either the third rail or overhead trolley type of eletcrical equipment at any time.

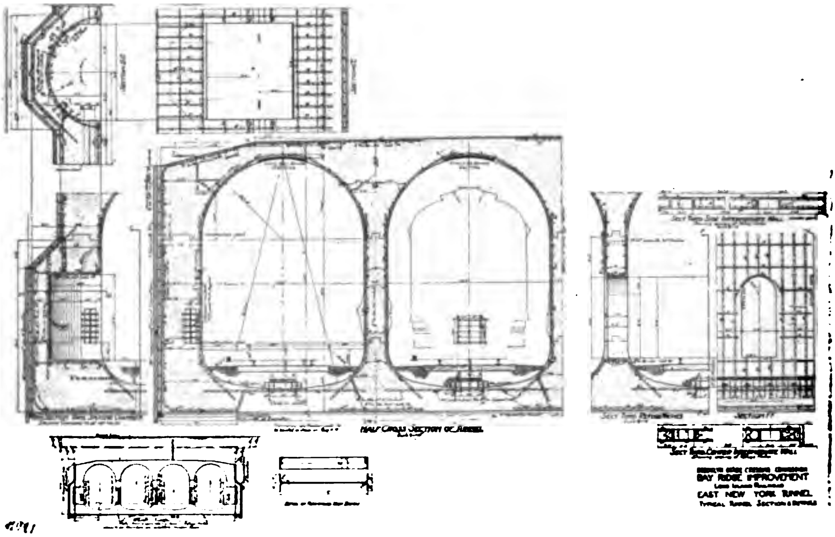

Fig. 136-3.

The extreme width of this four-track tunnel is regularly

69 feet 8 inches, widened out at the splicing chambers to 74 feet 8 inches. The height of the concrete structure from its foundation to the highest point is 24 feet and the cover from the top of the structure to the ground or street surface varies from a minimum of about 5 feet to a maximum of about 30 feet. The material through which the tunnel is built is a variable mixture of clay, sand, and gravel, in which are distributed irregularly an assortment of boulders, varying in diameter from 1 foot to a record size of 15 feet by 20 feet by 7 feet.

The railroad company purchased sufficient property not only to include the strip of ground directly above the tunnel structure, but enough to also allow a considerable margin on each side for construction tracks and partial slopes. These conditions combined made the "cut and cover" method the logical procedure, and this was the only method of construction considered.

From this description it follows that the tunnel structure had to be designed to carry a roof load due to an earth cover 70 feet wide, with a maximum depth of 30 feet, and to resist possible side pressures of indeterminate amount in a trench having a maximum depth of 54 feet. As shown, the section is a continuous elastic ring of reinforced concrete. While it is natural to speak of the roof and invert as arches, they could not act as such structurally unless the sides of the trench were absolutely unyielding and capable of taking the thrust from such arches before elastic stresses could be induced in the side walls.

It can be readily seen that if very soft, wet material is assumed and pressures from this material are allowed to come upon the sides of the completed structure before the roof covering has been placed, the effect will be to shorten the horizontal diameter of the structure and to lengthen the vertical diameter, thus causing tension on the inside of the side walls and on the outside of the invert and roof. On the other hand, if very stiff, dry material, not hard enough, however, to avoid the necessity of sheeting, and carrying irregularly distributed boulders, is assumed, it is possible to anticipate that, after the full roof cover had been placed, the side walls would receive no horizontal support until the tunnel structure had been considerably distorted and probably cracked, unless sufficient reinforcement were introduced to resist tension in the back of the side walls and on the inside of the roof and invert.

It is evident that these assumptions are both extreme and that they are exactly opposed to each other as regards the internal stresses induced in the tunnel structure. It, therefore, follows that if steel reinforcement is properly placed and given sufficient section to meet these extreme conditions without being stressed beyond the elastic limit, all intermediate conditions of loading will be amply provided for. Exactly this was therefore done and the reinforcement shown in the cross section has been designed by the most careful and modern methods available to accomplish it.

Passing to a detailed description of the second section mentioned; that is, between the south portal and the north side of Atlantic Avenue (see Fig. No. 4): The cover here was made as

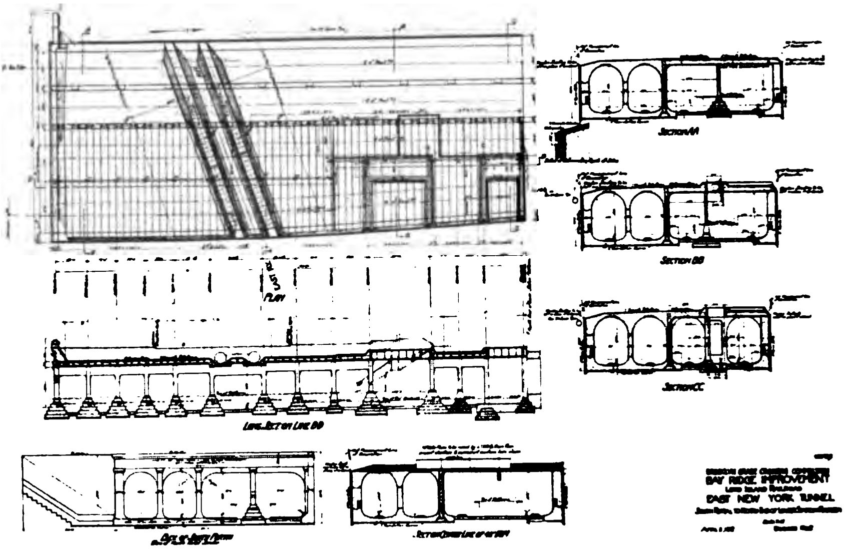

Fig. 136-4.

shallow as practicable, and as the two tracks on the east side had to be spread to accommodate the station platform it was necessary to abandon the regular reinforced concrete section over these tracks and substitute a flat roof construction consisting of shallow plate-girder roof beams about 3 feet center to center, supported on longitudinal girders and columns, all structural steelwork being completely embedded in concrete. Further complications in this part of the work were caused by the three 48-inch water mains aready mentioned which had to be raised about 1 foot 6 inches and be supported on the shallowest practicable construction to give the requisite track clearance, which was reduced to 15 feet

6 inches at these points instead of the 17 feet 6 inches provided elsewhere. The raising of these mains and the construction supporting them will be shown more in detail later in the description of the operations of construction.

Another feature affecting the plans for this section of the work was the temporary and permanent support of the Atlantic Division tracks of the Long Island Railroad. As previously indicated, these tracks carry a very heavy passenger traffic and the safe conduct of it was a very vital matter. This situation was further complicated by the fact that all eastbound trains discharged and took on passengers directly over the new tunnel and also by the presence of the live third rails for electrical operation. Electric supply cables were also carried in the duct benches on either side of these tracks. The railroad company regarded the safety of this situation of such importance that it had continuous double 20-inch I-beam stringers, fully spliced for both bending and shear, placed under each rail for the full length of track to be undermined, and also designed and furnished to the contractor permanent steel bents to be built into the tunnel walls (as shown on Fig. No. 5). The I-beam stringers, with new wooden ties, guard rails and planking were installed by the railroad company with its own forces and a watchman was kept on the spot day and night to guard against the possibility of any interference or

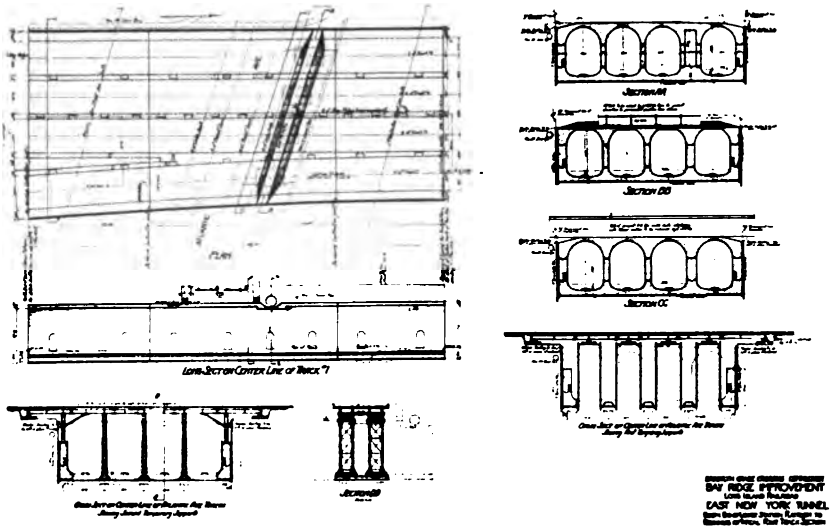

Fig. 136-5.

danger to trains. Railroad companies come in for a large amount of public criticism, but the extreme care with which they conduct their traffic and protect the lives of the traveling public is very little appreciated. It, therefore, seems only fair to publicly call attention to the great care exercised in this case, particularly as we have had in the recent past such conspicuous examples of the opposite practice of putting the undivided responsibility for such precautions on the contractor.*

Taking up the third section mentioned, namely: the special construction planned for the permanent support of the elevated railroad structures in Fulton Street and Broadway, the problem here was to build the tunnel in an open trench 70 feet wide and with a depth of 35 feet, and undermining five columns in Fulton Street, and with a depth of 45 feet and undermining seven columns in Broadway. The two cases were treated similarly in the plans and the explanation of the construction used in Broadway will serve for both. (See Fig. No. 6.) In order to reduce

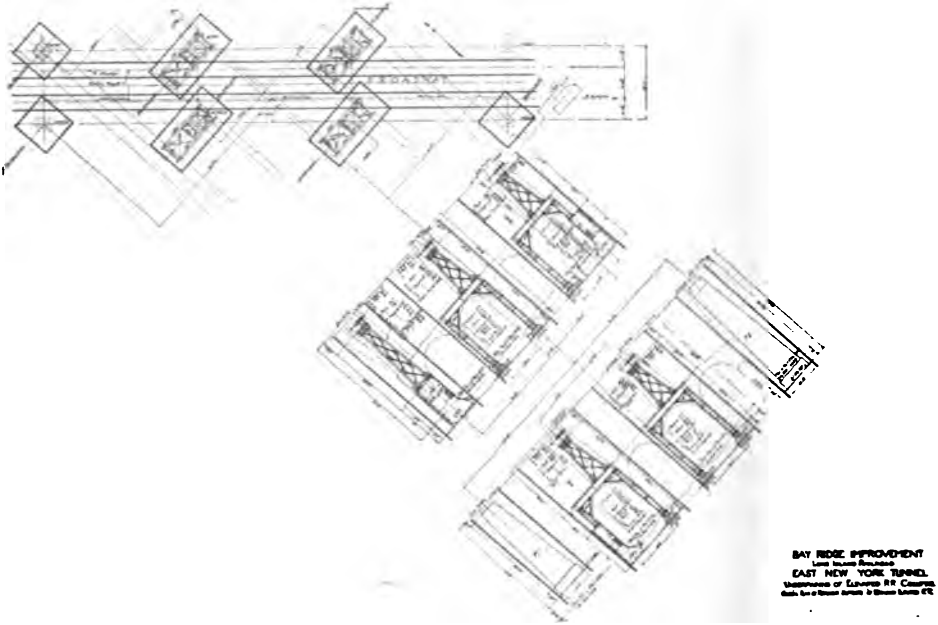

Fig. 136-6.

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* The failure of temporary timber structures built in connection with the execution of subway construction in Manhattan is here referred to.

as much as possible the length of the time during which the columns had to be carried on temporary supports the railroad company had permanent steel towers designed which could be erected on concrete footings in small pits and have immediate strength to entirely support the elevated columns as soon as erected. These towers were made in two stories. The lower story had its four vertical legs and bracing placed to come within the future walls and the two horizontal cross beams within the roof of the finished tunnel; while the upper story was a narrower tower reaching from the roof of the tunnel to the bottom of the column pedestal. Shims of various thicknesses were provided and the load of the column was transferred to the steelwork as soon as it was erected. The steelwork for these towers was shipped knocked down, was lowered into the pit in comparatively small pieces and the parts bolted (not riveted) together. As soon as practicable after these steel towers were erected a small section of the tunnel was built encasing the steel and giving it stability. (See Fig. No. 7.)

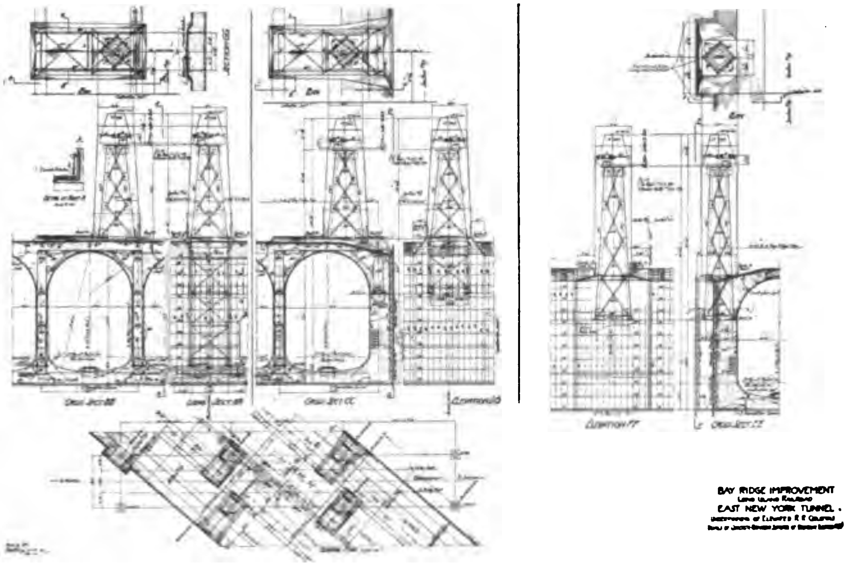


Fig. 136-7.

The plans for temporary support can be more favorably described as part of the construction operations.

OPERATIONS OF CONSTRUCTION.

The operations of construction can be most readily described in the approximate order in which they were executed. One of the first operations undertaken was

The Raising of the Forty-eight-inch Water Mains in East New York and Atlantic Avenues.

There were two of these mains in East New York Avenue and one in Atlantic Avenue. Figure No. 8 shows the method used. The main shown is in East New York Avenue and was raised 1 foot 6 inches. Years ago the raising of such large mains would have been considered quite an accomplishment, but so much of such work has been done in recent years that a regular standard procedure has been developed and the necessary equipment made available by the Board of Water Supply. The bent wrenches, bronze nuts and long screw-threaded rods were all rented by the contractor from the board and every detail of the work was carried out under the board's immediate supervision.

In at least one of these mains the water remained on at full pressure during the whole operation and though there was a movement of at least a quarter of an inch in many of the leaded joints there was no leakage of any consequence.

Figure No. 9 shows the temporary support of one of these mains by means of I-beams and wire ropes. When this picture was taken the steel roof beams had been erected and everything was ready for the placing of the forms for the concrete. It is to be noted that the water main crosses the roof of the tunnel at an angle, making skew connections necessary for the roof beams.

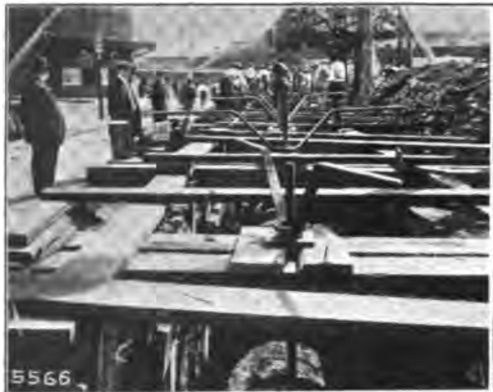
Figure No. 10 shows two mains still suspended from the temporary I-beams, but the concrete roof construction is completed ready for waterproofing. After this sand filling was placed and the mains received their permanent support on the new roof.

Following the order in which the work was executed the next operations to be described are those in the

Section South of Atlantic Avenue.

As has been previously stated, this section contains the special flat roof construction, the station platform and the south portal.

Figure No. 11 shows the general method of construction followed in this section. When this photograph was taken the two side walls, invert and part of the intermediate walls had been



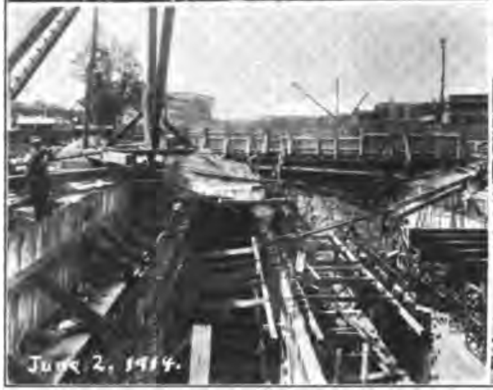
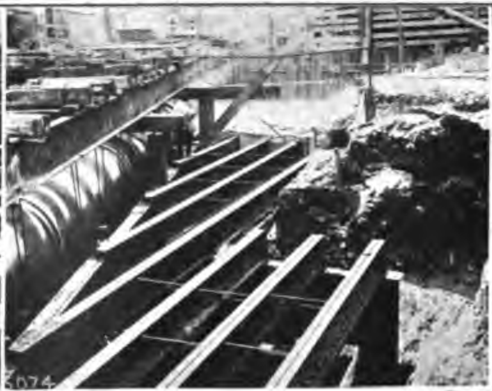


Fig. 136-8. E. N. Y. Avenue 48-inch Water Main.
Fig. 136-11. South of Atlantic Avenue.



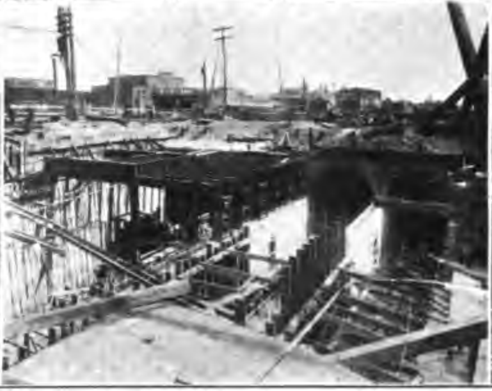
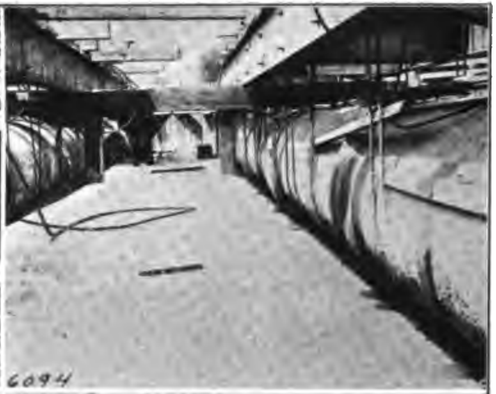


Fig. 136-9. E. N. Y Avenue 48-inch Water Main.
Fig. 136-12. View toward South Portal.



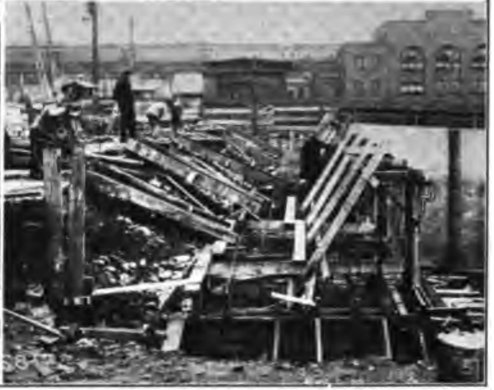


Fig. 136-10. Mains suspended from temporary I beams.
Fig. 136-13. Steel reinforcement skeleton--South Portal.

completed and the steelwork for the flat roof over the station platform had been erected. The view is toward Atlantic Avenue and behind the board fence pass the trains of the Long Island Railroad, Atlantic Division. At this time tube No. 4 and part of tube No. 1 were completed under Atlantic Avenue. The spouts indicate how the concrete was deposited; after being brought from the Herkimer Avenue mixer by cars through tube No. 1 it was lifted by derrick and dumped into the hopper, from which the spouts shown in the picture run to the walls and other portions of the construction.

Figure No. 12 shows the work in the same locality looking toward East New York Avenue and the south portal. Tubes No. 3 and No. 4 and the flat roof under East New York Avenue are completed; the steelwork shows the opening in the roof provided for the stairway from the station platform.

Figure No. 13 shows the skeleton of steel reinforcement for the south portal. The steel rods running at right angles to the axis of the tunnel have not yet been placed.

Figure No. 14 shows the south portal completed, except the station platform between tracks Nos. 1 and 2.

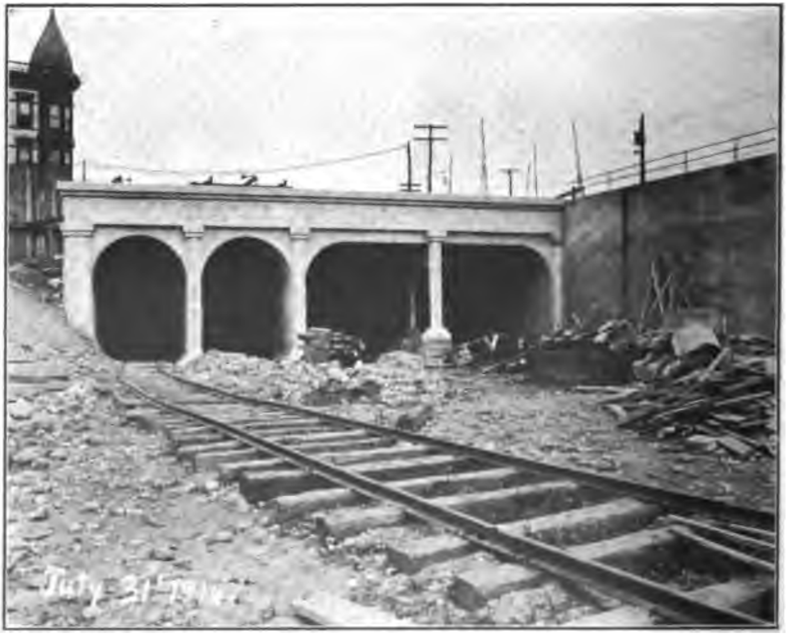


Fig. 136-14. South Portal.

Figure No. 15 shows the completed concrete passenger station platform.

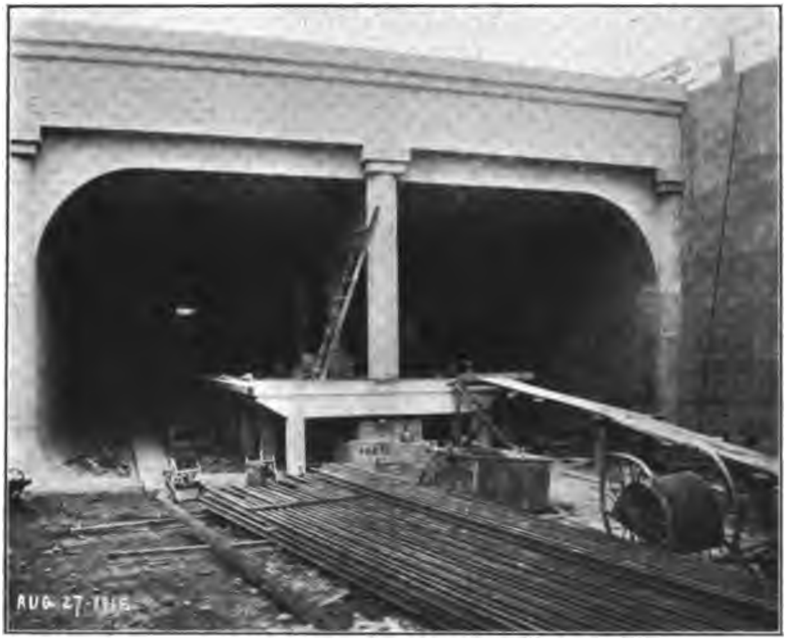


Fig. 136-15. Completed Concrete Passenger Station Plattorm.

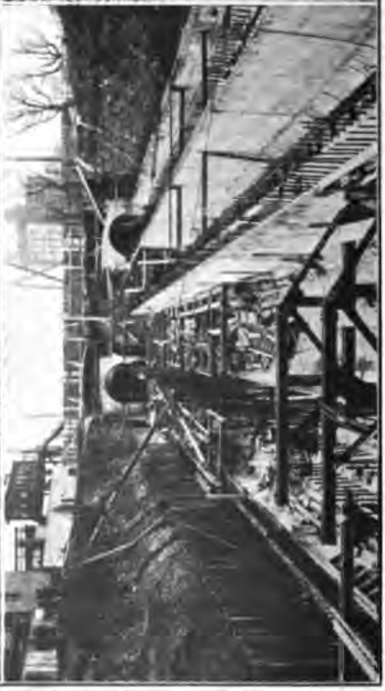
Next in order are the operations in the

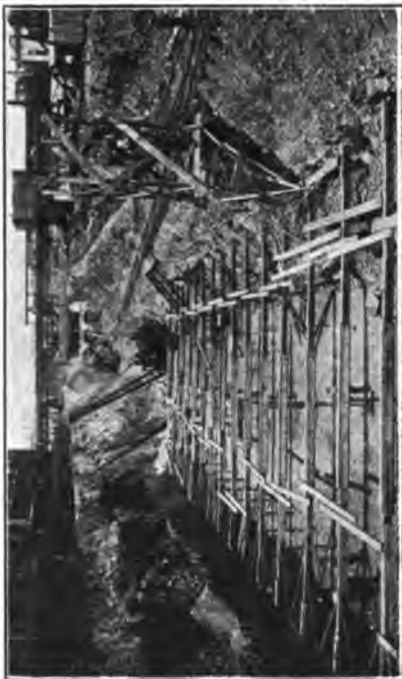
Section Between Atlantic Avenue and Fulton Street.

Figure No. 16 gives an excellent idea of the character of the material in which this portion of the tunnel was built, standing almost vertically at this point. The method of making the excavation by steam shovel in open cut is also shown. The shovel is about down to grade and the engine has to switch back twice to get out of the cut.

Figure No. 17 shows the timber bracing in place ready for the forms for the invert and walls for tubes Nos. 3 and 4 up to the first construction joint. The elevated storage bin of the Herkimer Street concrete mixing plant is also shown.

Figure No. 18 shows the construction in the same section just north of Atlantic Avenue. Tubes No. 1 and No. 4 are completed under the Atlantic Avenue tracks; the invert for all four tubes is completed, and three of the five tunnel walls have been brought up to the springing line ready for the roof arches. In





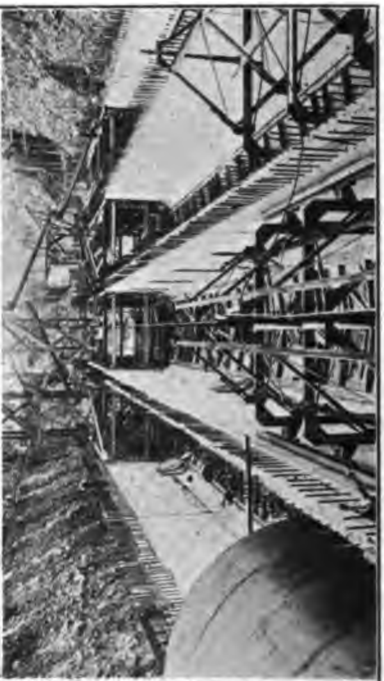


Fig. 136-16. Method of excavation between Atlantic Ave. and Fulton St.
Fig. 136-18. Construction just north of Atlantic Ave.

Fig. 136-17. Timber bracing ready for forms.
Fig. 136-19. Concrete Spout—Steel side and roof forms.

front of the picture are shown the steel frames for holding the steel forms for the vertical walls. The spout in view shows how concrete was poured from a small hopper car running on a narrow-gage service track on top of the bank.

Figure No. 19 shows the work in the same section further advanced. The spouting arrangement for placing the concrete is shown plainly, also the steel side and roof forms.

Figure No. 20 shows part of the roof completed and steel forms and rod reinforcement placed for one of the 40-foot sections into which the regular tunnel structure was divided. The roof arches for such a 40-foot section contained about 405 cubic yards of concrete; under favorable circumstances this was supplied by one mixer and poured in about 18 hours, making a performance of about 22½ cubic yards per hour. Afterward when the work was more fully organized, as high as 400 cubic yards in 10 hours, or 40 cubic yards per hour, from one mixer was placed.

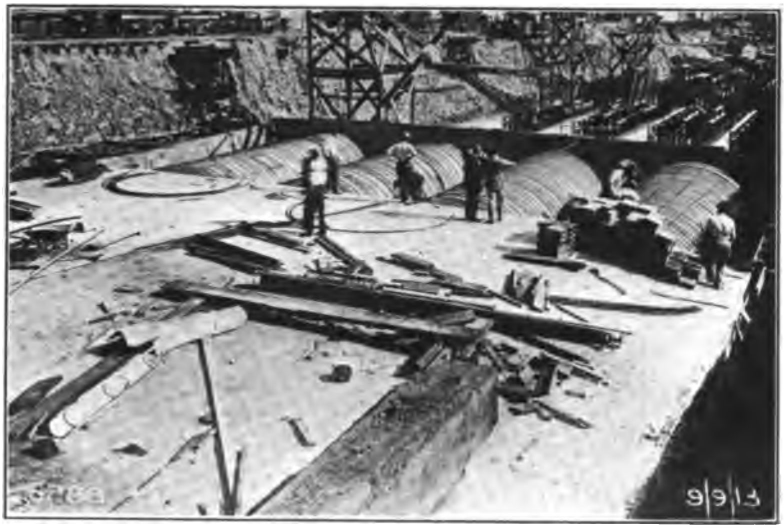
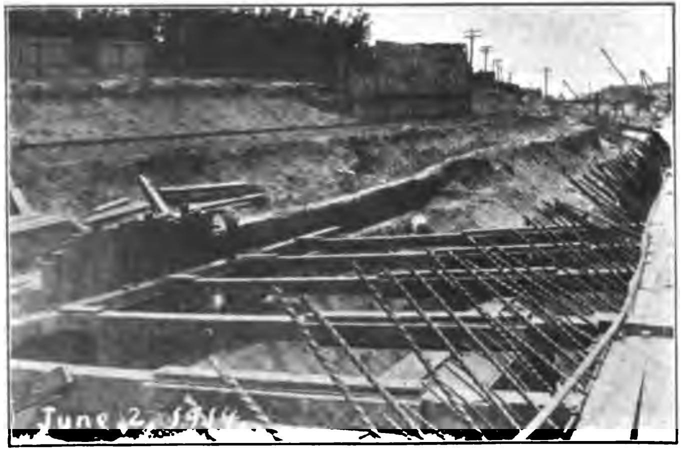


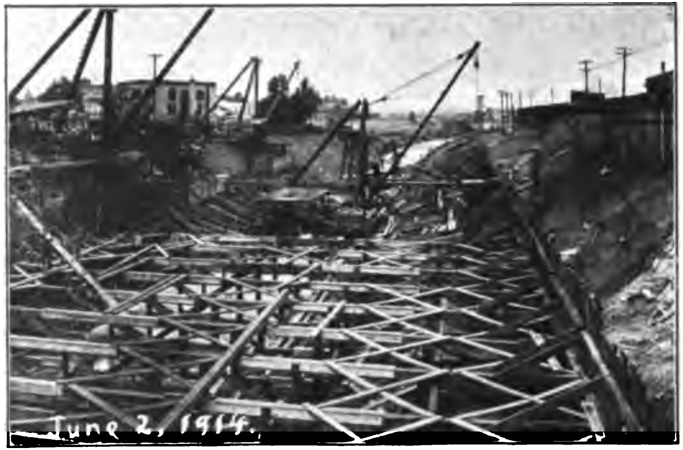
Fig. 136-20. Part of roof completed.

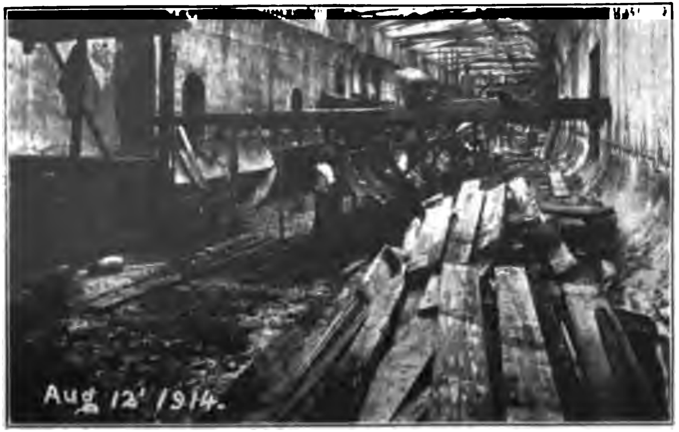
Next in order are the operations in the

Section Between Bushwick Avenue and the North Portal.

In this section the work had to be executed in close proximity to tracks of the railroad in regular operation and it was therefore decided to make the first excavation only wide enough for the







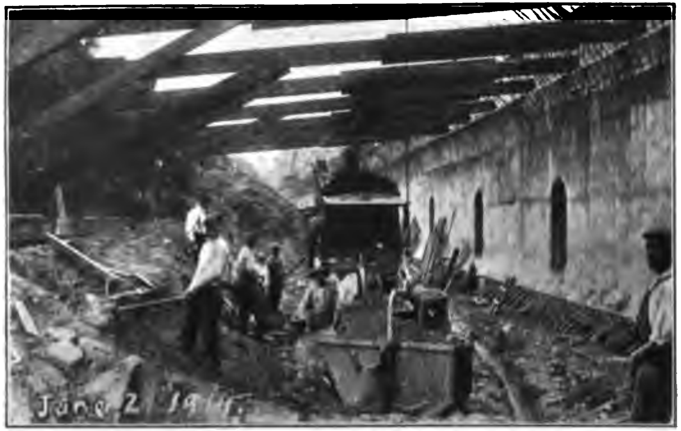


Fig. 136-22. Looking South
Fig. 136-24. Excavation completed and side walls built.

Fig. 136-21. Looking North.
Fig. 136-23. Excavation by steam shovel and hand labor.

NORTH OF BUSHWICK AVENUE.

two tubes farthest from these tracks, to construct tubes Nos. 3 and 4 in this narrow trench and to excavate for tubes Nos. 1 and 2 afterward, using the concrete structure first built to carry the bracing for the later excavation.

Figure No. 21 shows, in the foreground, the timbering used for the construction of tubes No. 3 and No. 4, considerable of which appears completed in the back of the picture. The elevating tower at the concrete plant at the north portal appears in the distance.

The surface tracks which were in use by the railroad company for regular traffic are seen on the right. The derricks shown are placed to handle excavated material from the side wall trench for tube No. 1 and deliver it on the cars on the service track; and also to handle buckets to place concrete as soon as possible after excavation is out of the way.

Figure No. 22 gives a better view of the railroad tracks, shows the edge of the completed tubes Nos. 3 and 4, with projecting reinforcement, and shows the sheeting being placed and the steam shovel at work to complete the excavation for tubes Nos. 1 and 2.

Figure No. 23 shows the same work viewed from below and shows the combination of steam shovel and hand labor in excavation. The loaded buckets were lifted by derricks above and dumped in cars on the service tracks. A small steam shovel with 19 feet 6 inches boom was used here and after the shovel had passed additional bracing was put in.

Figure No. 24 shows the same construction after excavation was completed and the last sidewall built. Forms are being placed for the invert up to the lowest construction joint of the intermediate wall between tubes Nos. 1 and 2.

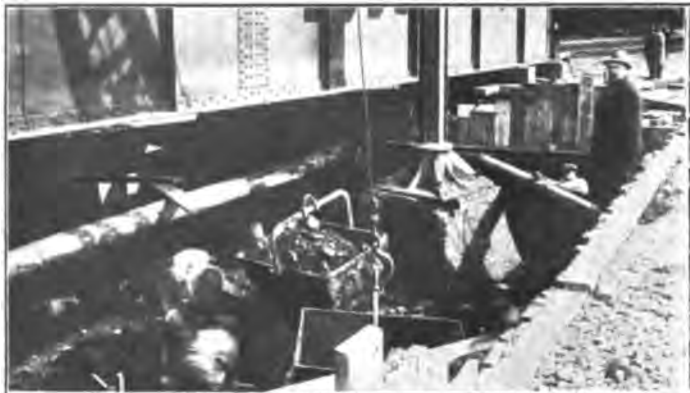
The next group of view illustrates the operations involved in the construction of the tunnel

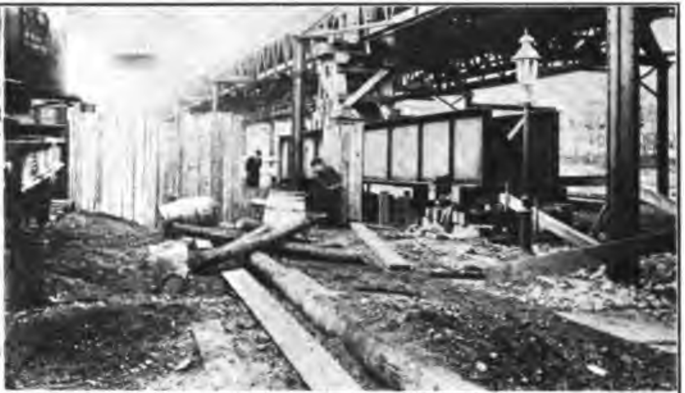
UNDER THE FULTON STREET AND BROADWAY ELEVATED RAILROAD STRUCTURES.

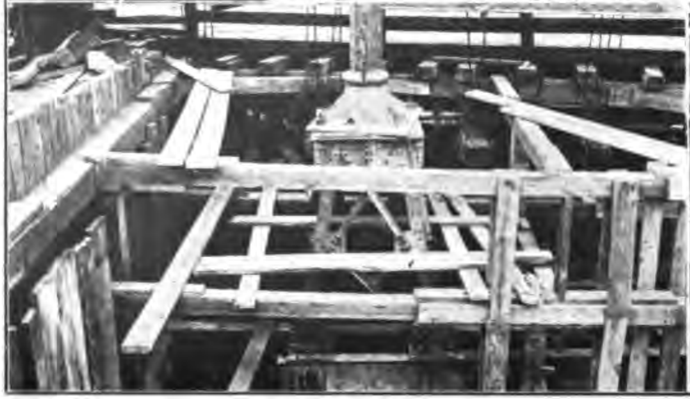
Figure No. 25 shows temporary girders in place supporting the Fulton Street structure and excavation just starting to undermine one of the columns.

Figure No. 26 shows the timber tower and temporary supporting girders at the same column.

Figure No. 27 shows the steel tower and lower steel frame (erected under the same column), giving immediate support







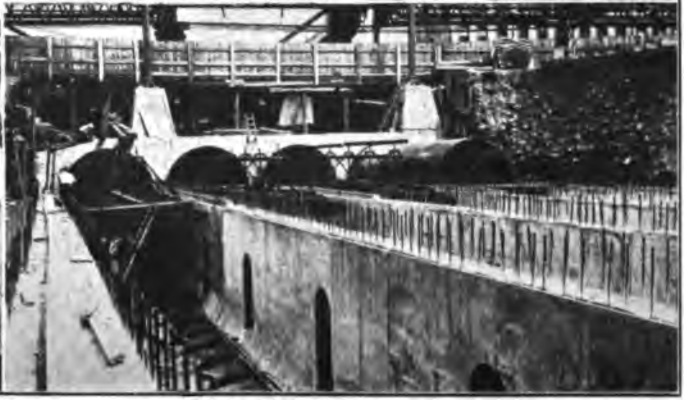


Fig. 136-25. Temporary girders supporting Fulton St. structure.
Fig. 136-26. Timber tower and temporary supporting girders.
Fig. 136-27. Supporting steel tower and lower steel frame.
Fig. 136-28. Fulton St. elevated column on permanent tunnel support.

UNDER FULTON STREET AND BROADWAY ELEVATED RAILWAY STRUCTURES.

to the column and at the same time giving the required clearance for the tunnel.

Figure No. 28 shows the elevated railroad columns in Fulton Street carried by the new permanent construction of the tunnel, and also gives a good view of the steel forms for the tunnel roof construction.

Figures Nos. 29 and 30 show the temporary construction designed for the support of the elevated railroad structure in Broadway, consisting of two double lines of plate girders placed just outside the columns, leaving the entire space inside the columns clear for vehicles and trolley traffic. These girders were placed end to end and fully spliced for both shear and bending and, for the first operation, while the columns were being undermined, they received their support on blocking placed on the ground about midway between the columns. While supported in this way the pits shown in the plan were timbered and excavated to their full depth and the steel towers previously described were erected on concrete footings forming part of the regular tunnel section. Short pieces of the regular tunnel section were then built and all this steelwork surrounded and filled with concrete. When this was accomplished, for all the pits, the elevated structure was fully carried by parts of the new permanent tunnel structure

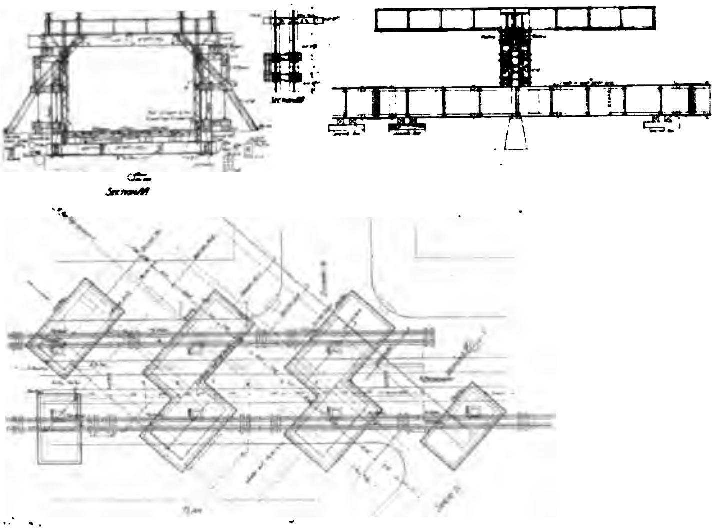


Fig. 136-29.

and the subsequent operations more clearly shown in Figure No. 30 were carried out. As soon as the elevated structure was carried by these permanent supports, the timber work above the temporary girders was of no further use, and by slightly enlarging the tops of the towers under these columns, as shown in Figure No. 30, it was possible to make them carry the temporary girders, to do away with all other supports and, having previously put in a floor system of steel I-beams and wooden stringers suspended from the girders, to leave the space below entirely free and clear of obstruction for the completion of all construction operations.

Figure No. 30 shows more particularly the details of the suspended floor system, the methods used to support pipes, ducts, etc., and the blocking on the piers to carry the temporary girders during the final operations and until backfilling was completed.

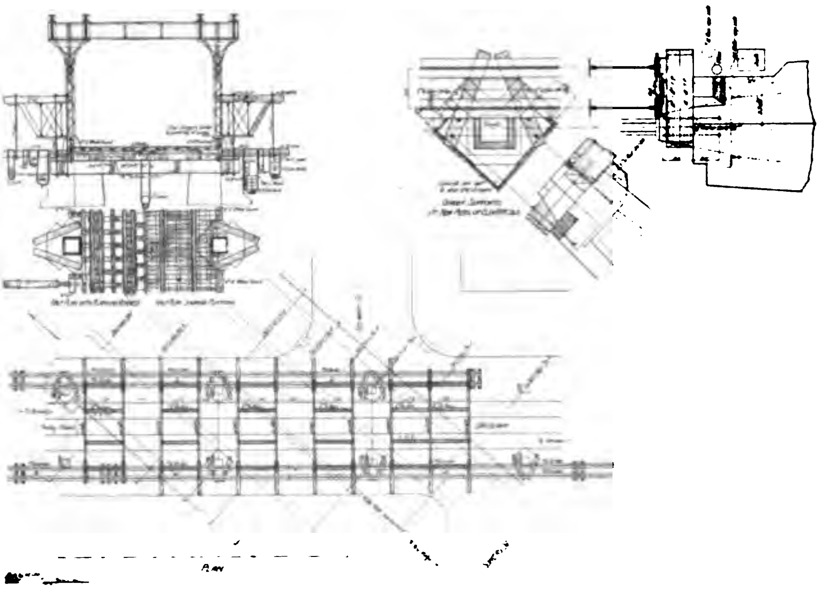


Fig. 136-30.

The execution of these plans is shown by the photographs of the work reproduced in figures Nos. 31 to 37 inclusive.

Figure No. 31 shows the portion of Broadway to be undermined by the tunnel before the pavement was disturbed.

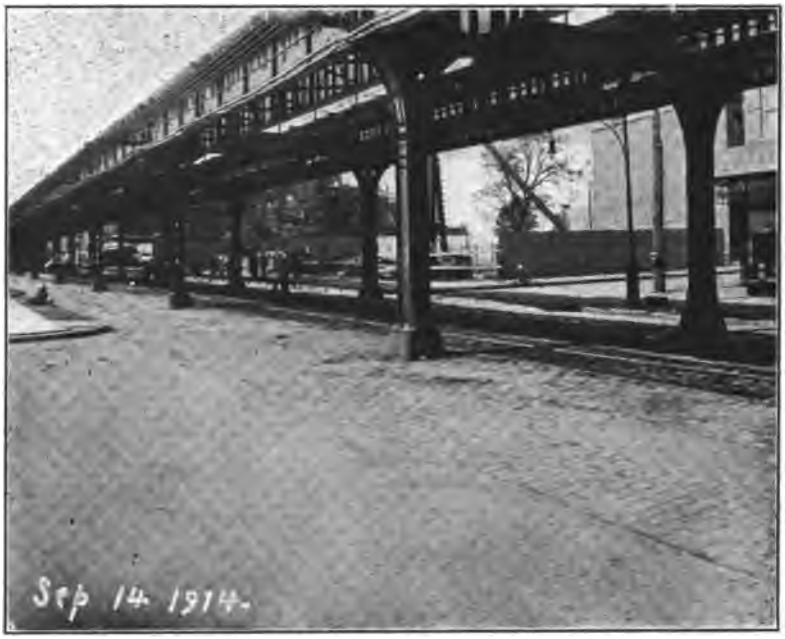

Sep 14 1914.

Fig. 136-31. Broadway at tunnel crossing, looking northwest.

Four columns on the near side and three on the far side had to be undermined.

Figure No. 32 shows the temporary floor in place and planked. Part of the temporary girders, wooden towers and overhead I-beams are in place and the trolley wires are being attached to the temporary overhead beams.

Figure No. 33 shows the temporary girders, timber towers and overhead I-beams all in place and part of the floor beams suspended.

Figure No. 34 shows two of the elevated railroad columns on their permanent supports and the same supports now carry the temporary girders, the suspended floor, pipes and all the ducts.

Figure No. 35 shows all columns on this side of street on permanent supports. Timber towers and overhead girders are no longer needed, but have not yet been removed. The excavation for the full 70 ft. width of the tunnel has been made and the regular timbering is shown extended under the suspended street.

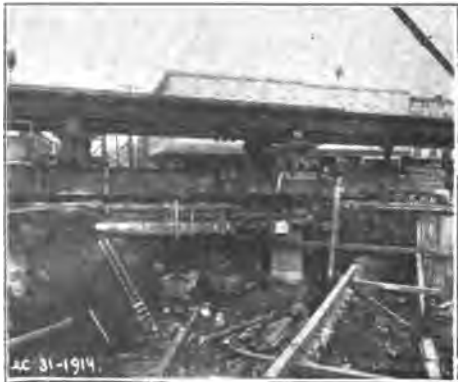


Fig. 136-34. Two elevated railroad columns on permanent supports.

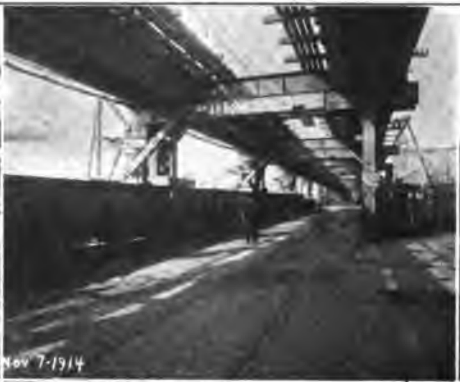


Fig. 136-33. Part of floor beams suspended.

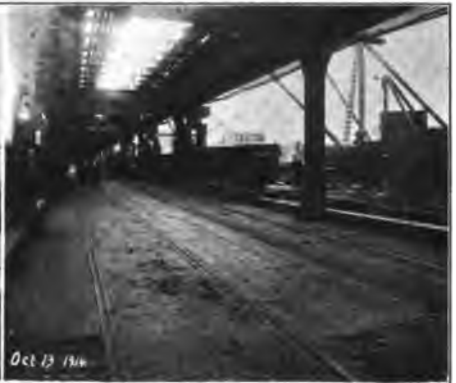


Fig. 136-32. Temporary floor in place.

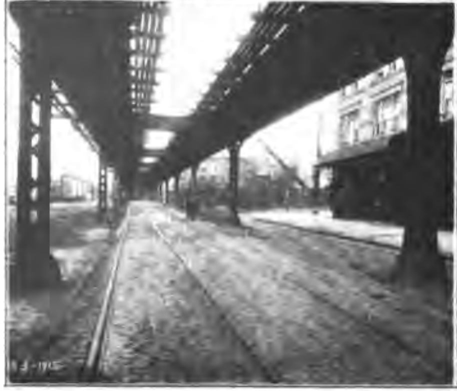


Fig. 136-37. Street restored and temporary supports removed.

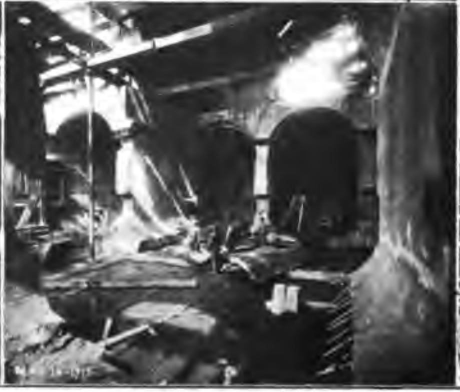


Fig. 136-36. Excavation under the street completed.

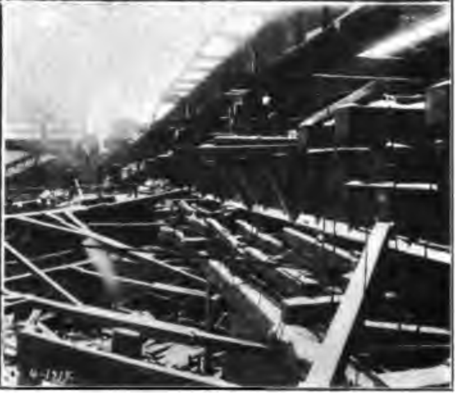


Fig. 136-35. All columns on this side of street on permanent supports.

BROADWAY ELEVATED.

Figure No. 36 shows the excavation under the street completed and the short pieces of tunnel section built in the pits as previously described, fully exposed.

Figure No. 37 shows the street restored and temporary supports removed. The paving is not replaced, awaiting the probable settlement of the backfill.

Next in order is the description of the methods of construction adopted for the major part of the regular tunnel structure and used, with the exception of the short special section under Broadway, for the entire

Section from Fulton Street to Bushwick Avenue.

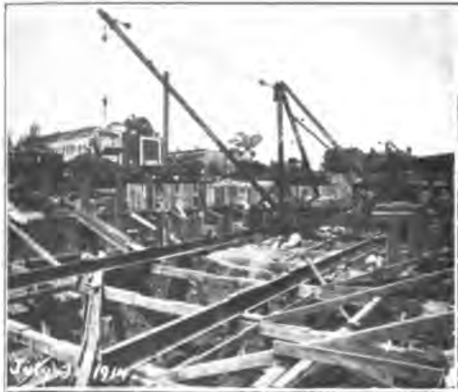
This method consisted in excavating the trench to full width by steam shovel from the orginal ground surface down to the level of the future tunnel roof, then placing heavy braces 70 ft. long, fully sheeting the wide trench and starting two narrow trenches in which to build the two side walls. After these sidewalls were built, the remaining excavation between them was removed also by steam shovel and the intermediate invert, walls and roof, were constructed.

Figure No. 38 shows the excavation completed for the wide trench down to the elevation of the top of the tunnel roof, the 70 ft. braces blocked up on the ground and the rangers and sheeting being placed.

Figure No. 39 shows the two narrow trenches being excavated just inside of the limits of the wide trench previously shown. A standard gage service track is shown on one side on which the excavated material from the two trenches is being loaded in buckets served by the one traveling derrick in the center, and there is a narrow gage track on the other side on which the concrete was later brought in cars and spouted into the two walls.

Figure No. 40 shows the sidewalls completed and the steam shovel at work at lower level removing the prism of earth between them. The long I-beams shown served the purpose of supporting the 70 ft. braces vertically at the point where the steam shovel was at work.

Figure No. 41 shows the excavation between the side walls completed and shows the vertical wrought iron pipes, filled with concrete and resting on a concrete block, which were used to support the long braces and which were after-



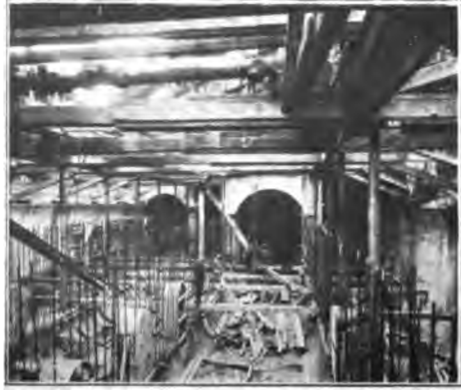
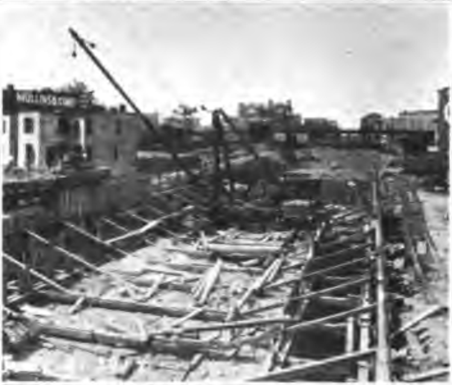


Fig. 136-40. Side walls completed.
Fig. 136-43. Invert completed.



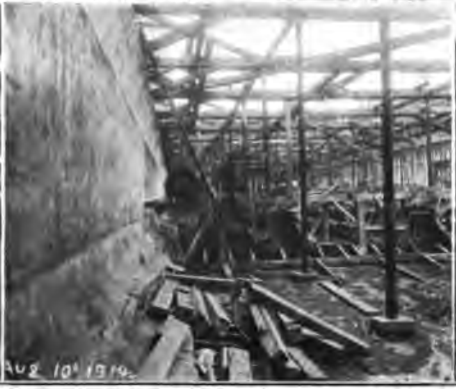
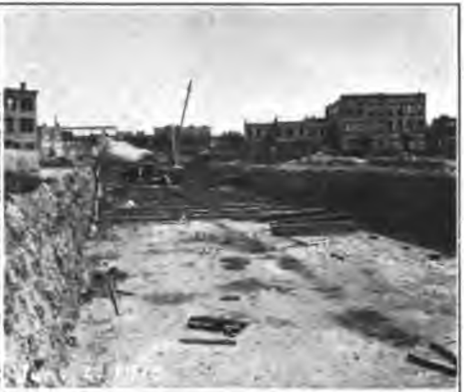


Fig. 136-39. Trench excavations inside lines of wide trench.
Fig. 136-42. Inverts for intermediate walls in place.



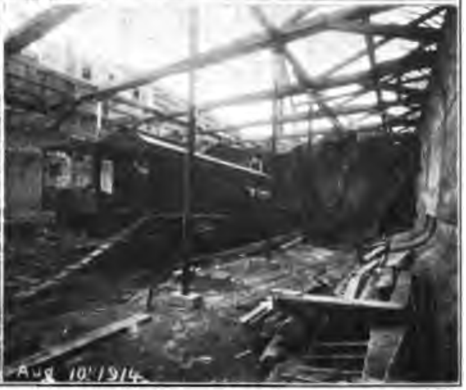


Fig. 136-38. Wide trench excavation completed.
Fig. 136-41. Excavation between side walls completed.

FULTON STREET TO BUSHWICK AVENUE.

wards built into the intermediate walls of the tunnel. The steam shovel is also shown at work.

Figure No. 42 shows the 2" foundation course placed and the forms and reinforcement for the invert and bottom portion of intermediate walls in place.

Figure No. 43 shows the invert completed and the forms for the refuge niches in place. The completed tunnel concrete ahead is under Broadway and surrounds the steel frames supporting the elevated railroad columns.

Figure No. 44 shows the timber bracing as a whole after excavation and sidewalls were completed.

Figure No. 45 shows the steel roof forms and the circular steel rod reinforcement in place ready for the roof concrete.

Figures No. 38 to No. 45, inclusive, illustrate the methods of construction, timbering, etc., used between Fulton Street and Broadway. Those used between Broadway and Bushwick Avenue were substantially the same, but the depth of the open trench was greater, the character of the material was less reliable and buildings were located close to the excavation. Heavier timbers and sheeting were therefore used and the work was executed with particular care.

Figure No. 46 shows the heavier timbering just referred to, the 70-foot braces being made of two 12 inch by 12 inch sticks, one above the other. It also shows the steam shovel at work at the lower level and the wrought iron pipes filled with concrete ready for use in the vertical support of the long braces.

Figure No. 47 shows the substantial character of the timbering and the most excellent framing and regularity of construction accomplished in the last operations of this work. On the left hand side is shown the standard gage track on which excavated material was handled and on the right hand side the narrow gage track and the small locomotives and the cars by which concrete was delivered and from which it was spouted in the forms.

After the work in this last section was fully organized about 240 feet of the regular four-track tunnel structure was completed per month.

Contractor's Plant.

Before closing this description it seems desirable to give a short description of the plant and equipment by which these results

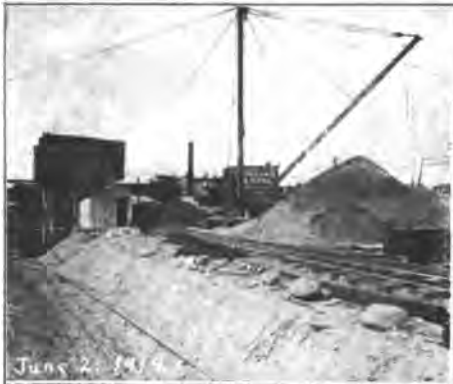


Fig. 136-49. Derrick to place stone and sand in elevated bins.

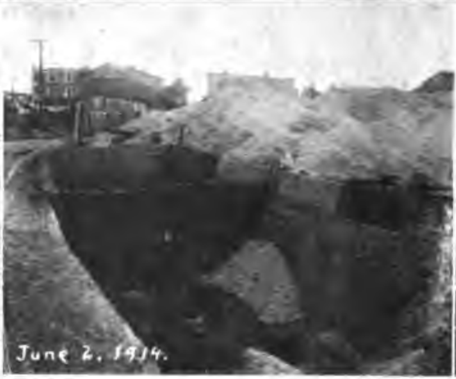


Fig. 136-48. Depressed bins for stone and sand.

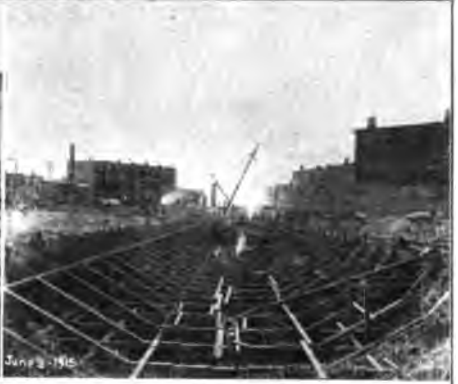


Fig. 136-47. Excellent character of timbering.

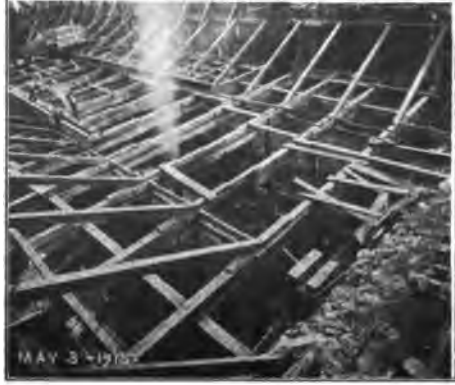


Fig. 136-46. Heavy timbering in deep excavation.

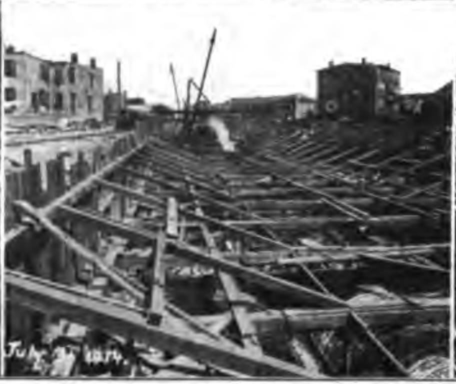


Fig. 136-45. Steel roof forms and rod reinforcement in place.

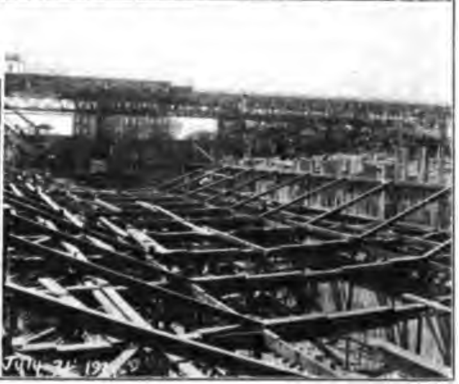


Fig. 136-44. Timber bracing after completion of excavation and side walls.

were accomplished. In looking at the views which are given it must have been evident, not only that the timbering, forms, etc., were well planned, simple and substantial; but that the equipment used was of the same general character, and it gives a good idea of the extent and character of the work to know that the principal parts of this equipment were as follows:

3 Marion steam shovels, 2 of Model 60, with 2½ cubic yard buckets and 25 feet 6 inches height of boom.

1 of Model 40, with 1½ cubic yard buckets and 19 feet 6 inches height of boom.

2—30-ton locomotive cranes.

10—15-ton capacity derricks.

2 Standard gage 22-ton locomotives.

5 Narrow gage 8-ton locomotives.

12 Standard gage, steel body, flat cars of 100,000 pounds capacity, capable of bringing 2,400 barrels of cement to the job at one time.

38 Standard gage Western Dump cars of 12 cubic yards capacity.

13 Narrow gage flat cars.

2 Standard 1 cubic yard concrete mixers.

Figures Nos. 48 and 49 show the type of concrete mixing plant used.

Figure No. 48 shows the depressed bins into which the broken stone and sand were dumped from cars to supply the concrete mixer plant near Herkimer Street. The delivery track seen is a spur from the Long Island Railroad tracks in Vesta Avenue, which are also visible. Back of the bins are the piles of accumulated stone and sand, and by looking closely the clam shell bucket by which it is further handled can be seen.

Figure No. 49 shows the same piles of stone and sand seen in the previous view and also the derrick by which they were lifted to the elevated bins from which they passed to the one yard Ransom mixer below, which is out of sight. The small car on the narrow gage track is one of the hopper cars in which the concrete was transported and from which it was poured into spouts and deposited in the work.

Another plant practically the same as the one at Herkimer Street was located at the north portal and all concrete for the work was made at either one or the other of these two plants. The best month's work for one of these plants was 5,020 cubic yards.

CONCLUSION.

The work was practically completed and two tubes of the tunnel were put into operation in November, 1915.

The entire work was planned and executed under the direction of Mr. Lardner V. Morris, Chief Engineer, and Mr. J. E. Breen, Principal Assistant Engineer, of the Bay Ridge Improvement. Mr. J. P. Patterson was Assistant Engineer in charge of field work.

Walter H. Gahagan, Inc., was the General Contractor.

The writer was responsible for all of the detail plans and was Consulting Engineer throughout the design and execution of the work.

Acknowledgment is due both to Mr. Morris and to Mr. Gahagan for their generous assistance in the preparation of this paper.

DISCUSSION.

In answer to the President's remarks, in which he asked what was to be the ultimate purpose of this four-track railroad in connection with which the Bay Ridge Improvement was started sometime in 1904, and seems to have shown little activity since, Mr. French spoke as follows:

Mr. French: It is not correct to infer that the work that has been done on the Bay Ridge Improvement since 1904 has not been active, or that it has simply been a matter of expenditures. Each step has been a substantial accomplishment. The tracks constructed in the lower part of Flatbush have been in constant use; terminal yards have been provided and freight business that never existed before has been developed; and every part as soon as completed has been put into immediate use and has earned more revenue. Although its main purpose cannot be accomplished until the Hell Gate Bridge is completed the improvement has accomplished important results at every stage. If it has done nothing more, it has benefited both the public and the railroad company by reducing the danger of grade crossing accidents. A large number of grade crossings were eliminated before this tunnel work was started and its completion eliminates a considerable number more. The main function of the improvement is, of course, to serve as a connection between the Pennsylvania and N. Y., N. H. & H. R. R. systems and that function will not be served until the Hell Gate Bridge is finished, in probably about a year from now, but independent of this main ultimate purpose the incidental and immediate results have been of very substantial benefit to all concerned.

In reply to a few remarks that were made to the effect that the portion of the New York Connecting Railroad immediately north of the Bay Ridge Improvement is not yet completed, Mr. French said:

Mr. French: The only link lacking is under contract and is being built; the contractors have undertaken to build it within a year and the work will probably be completed as soon as the Hell Gate Bridge is open for traffic.

Question: Then the whole line from Bay Ridge to the New Haven Railroad connection is either under construction or has been completed?

Mr. French: Yes; practically.

In answer to the President's question: "Who paid this $1,100,000 for the work just described?" Mr. French replied as follows:

Mr. French: It was partly paid for by the city, but the major part of the expense was borne by the railroad. The exact accounting is a complicated matter and the details are not at hand to enable me to speak accurately. The city undertook part of the expenses to eliminate grade crossings and provide equivalent trackage to that in existence when the law was passed, but the railroad company, attacking the work on broad lines, decided that they should not restore simply the tracks which were there before, but should stand the expense of increasing their facilities to meet future needs. The city's share is based on the original conditions and the railroad company pays the remainder.

Mr. Strachan: What is the rate of grade through the tunnel?

Mr. French: Seven-tenths of 1 per cent. The alignment is straight with the exception of a little curvature to separate the tracks for the island platform at the south end and a short curve at the north end.

In answer to a question by Mr. Nelson asking the length of the tunnel Mr. French answered that the tunnel's length is about 3,500 feet or five-eighths of a mile.

BROOKLYN ENGINEERS' CLUB

No. 137

TELEPHONE TRAIN DISPATCHING AND SAFETY APPLIANCES NEW YORK MUNICIPAL SUBWAYS

By E. E. Trafton, Mem. B. E. C.
Presented March 9th, 1916.

It is because of the recent advances in the art of telephone transmission and due to the splendid results obtained by the application of some of these new principals on the new lines of the Brooklyn Rapid Transit System that the speaker considers a discussion of this topic, together with certain phases regarding subway safety appliances as timely, especially to the engineering profession of our Borough. Accordingly the honored invitation of your Entertainment Committee to present notes on the subject of telephone train dispatching and safety appliances, as installed on the lines of the New York Municipal Railway Corporation, was accepted.

As an aid in explaining the various kinds of apparatus used and how they work in actual practice, sample parts have been brought to the Club Hall and demonstration will show what is daily accomplished between distant signal towers, trainmaster's headquarters and the Chief Dispatcher's office of the Transportation Department.

With reference to the areas and distances involved and the relative positions of the important signal towers, sub and power stations, dispatcher's office, new subway lines, etc., certain official drawings have been reproduced on positives for lantern slides and these, together with pictures of installed apparatus, are presented herewith.

Fig. 1 indicates all of the old and the new lines where operation is contemplated by the Brooklyn Rapid Transit System under the Dual Subway Contract.

Fig. 2 indicates to what extent the proposed telephone cable installation has been completed at this date, and the combined length of cable pairs shown thereon amounts to a little over eight million feet. This cable plant furnishes special conductors for the dispatching of trains by telephones and also circuits for our general telephone systems and Emergency Alarm

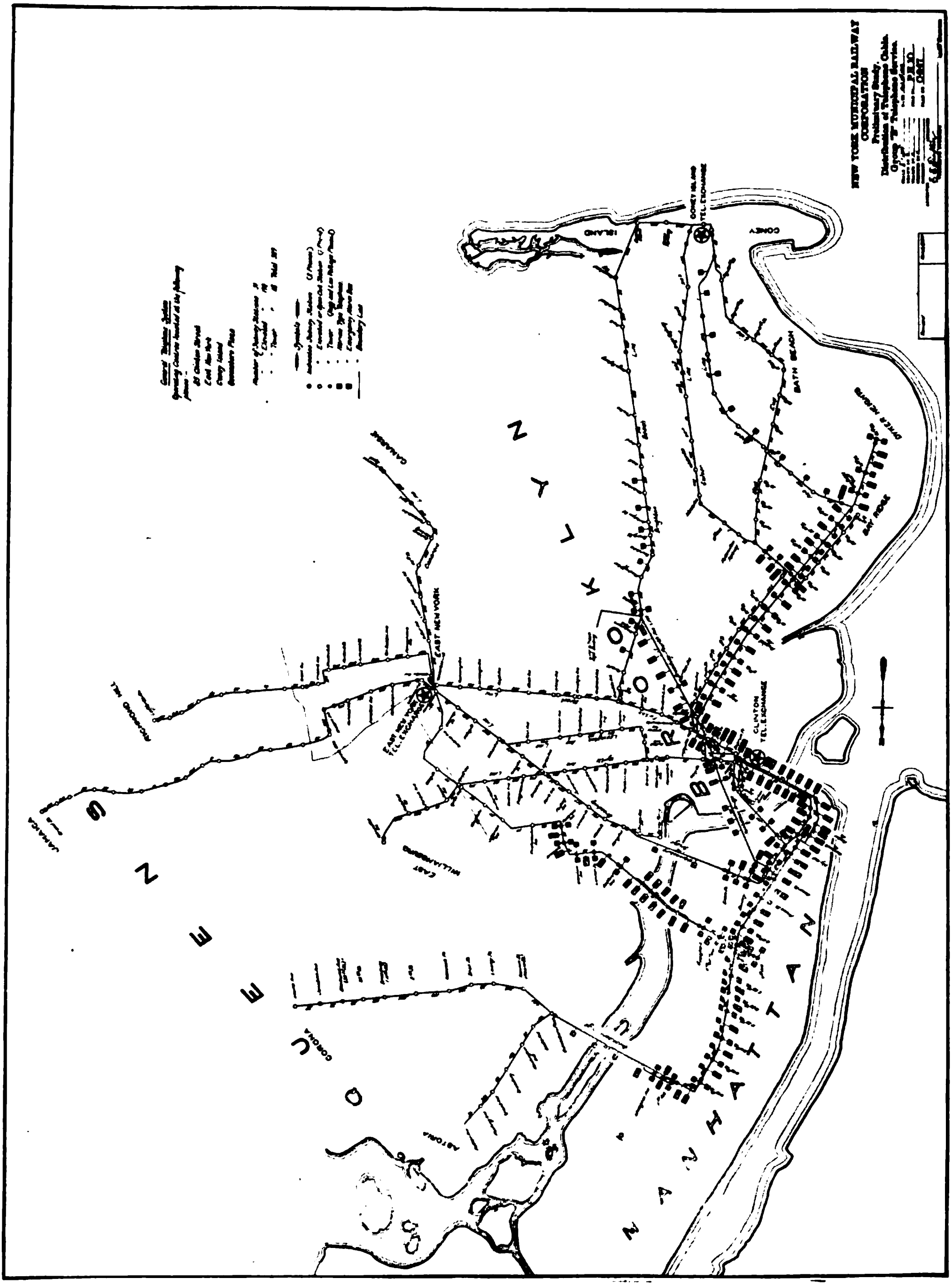


Fig. 137-1.—Dual Subway System, B. R. T. Operation.

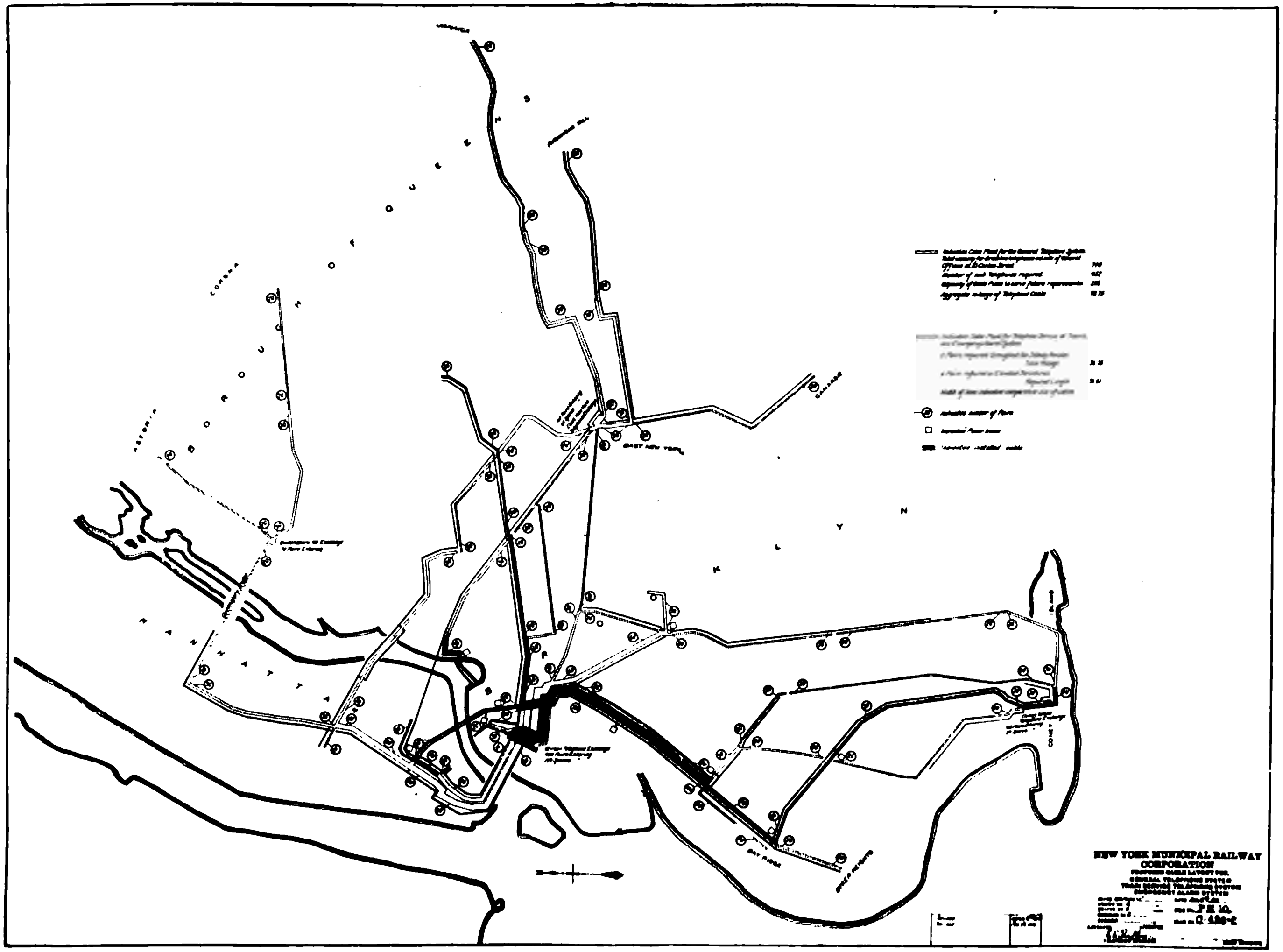


Fig. 137-2. —Heavy Lines Indicate Completed Cable Installation.

Equipment. These cables were installed on account of the special requirements of the Railway. It should be noted that the average length of all the circuits radiating from our General Office at 85 Clinton Street amounts to only one-half the distance to the same points along our right of way as would be the case through the duct lines installed along our streets.

In order to handle trains by telephone instead of telegraph, circuits had to be provided with sufficient copper to permit of commercial transmission with about thirty-two towers connected on one line, and the attenuation or loss in transmission of such a circuit would be such as to require No. 16 B. & S. gauge with 44 ohms and .074 Mfd. electrostatic capacity per mile, which is the equivalent of about 4 circuits of the Telephone Company's standard No. 22 B. & S. gauge local subscriber's cable.

The wires now installed have furnished connections for about 250 additional telephones; most of which are direct lines to our switchboards.

A typical manhole for splicing and terminating wires of cables is shown by these two pictures taken by the Public Service Commission photographer at DeKalb Avenue Station. It should be noted that the terminal equipment is separated from high tension cables by a reinforced concrete wall to prevent electric arcs from reaching it, and where our cables are exposed to arcing they are wrapped with rope spirally and two layers of cement applied, the resulting effect of this being shown in this picture where asbestos listing is punc-

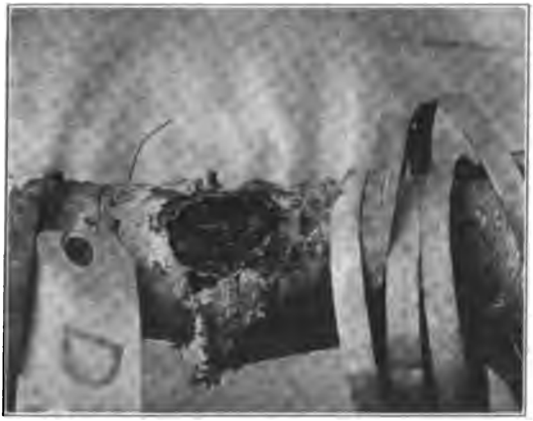


Fig. 137-3.—Asbestos Covered Cables Ruined in 55 Seconds by an Arc of 800 Amperes at 240 Volts.

tured and cable ruined in 55 seconds by an arc of 800 amperes at 240 volts (Fig. 137-3), but the same arc across the same cable protected by cement as described before is not even injured in 4 minutes time. (Fig. 137-4.) So far as I know this is the first telephone cable plant installed with cement protection, the contractor being J. A. Roebling Sons Company of New York. A saving can be effected by using special alloy of metals making a wire mesh instead of rope for holding the cement.

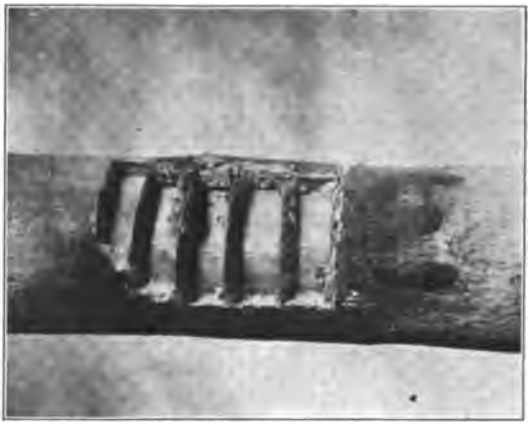


Fig. 137-4.—Cables Wrapped Spirally with ⅜-Inch Rope and Two Layers of Cement Not Injured in 4 Minutes Arc of 800 Amperes at 240 Volts.

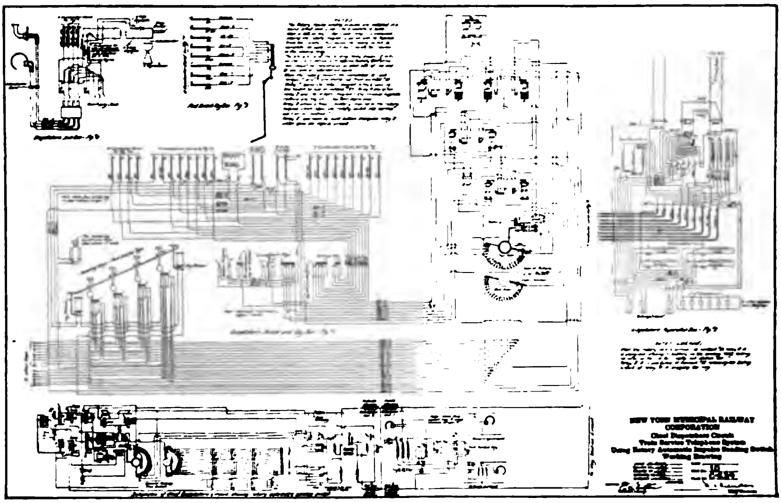


Fig. 137-5.—Central Office Equipment Train Dispatching System.

Because of the extensive fire at the Roebling plant most of the cable was manufactured by the Standard Underground Cable Company and the sample cable-board furnished by them shows the thickness of lead sheath and the cable formations as well as all of the electrical constants.

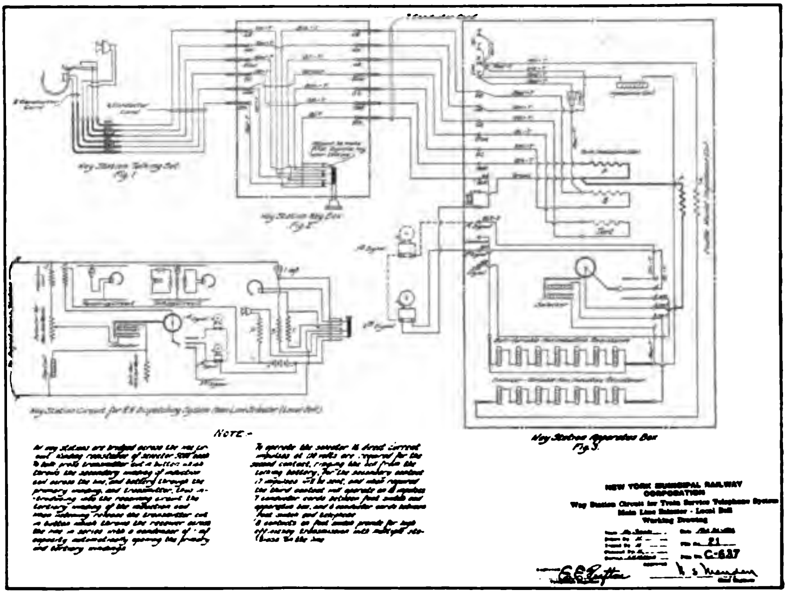

Note -
Fig. 3.
NEW YORK MUNICIPAL RAILWAY
CORPORATION
Way Station Circuit for Train Service Telephone System
Main Line Selector - Local Bell
Working Drawing
21
C-637

Fig. 137-6.—Way Station Equipment Train Dispatching System.

Fig. 6 shows the circuit used for train dispatching telephones in way stations or signal towers and Fig. 7 shows one installed in a tower. Thirty-two of these instruments are arranged for service on one circuit known as the train dispatching circuit of the Eastern Division. In the circuit for the Way Station or Signal Tower Equipment you will please note the selector as shown is bridged directly across the main line with an impedance coil in series with same on both sides which coils are used only as balancing choke coils to eliminate all line disturbances. In series with this selector is a non-inductive tapering resistance for the purpose of allowing adjustment to be made so that each station will carry the same amount of current, which is about seven one-thousandths of an ampere. All selectors respond simultaneously to impulses of 110 volts direct current sent to the line. A predetermined code allows only the particular selector with that code to operate its full cycle, other selectors dropping away during this cycle due to their being set to operate on different codes or combinations.

This particular selector, which was designed to meet our special requirements, was arranged with three contacts, one being used as an auxiliary contact, one as a signal for the regular bell, and another for signalling a second or extension bell.

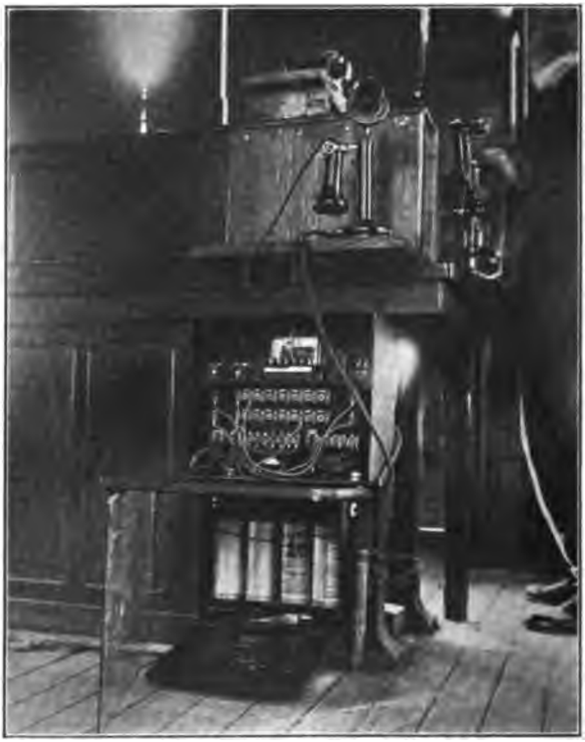


Fig. 137-7.—Signal Tower Equipment Train Dispatching System.

The telephone circuit is of a special local battery type having two separate talking and listening circuits controlled by a foot switch. Both of these circuits are arranged for high efficiency which is brought about by the introduction of a specially wound induction coil having a primary, secondary and tertiary winding. With the foot switch in normal position (for listening only) the receiver in series with one Mfd condensor is all that bridges the line. While talking it is necessary to depress the foot switch which alters the entire circuit as follows:

1. The receiver is cut off the line circuit and placed in series with the tertiary winding of the induction coil.
2. The secondary winding is placed across the line in series with the condensor.
3. The battery circuit is closed through the transmitter and primary winding.

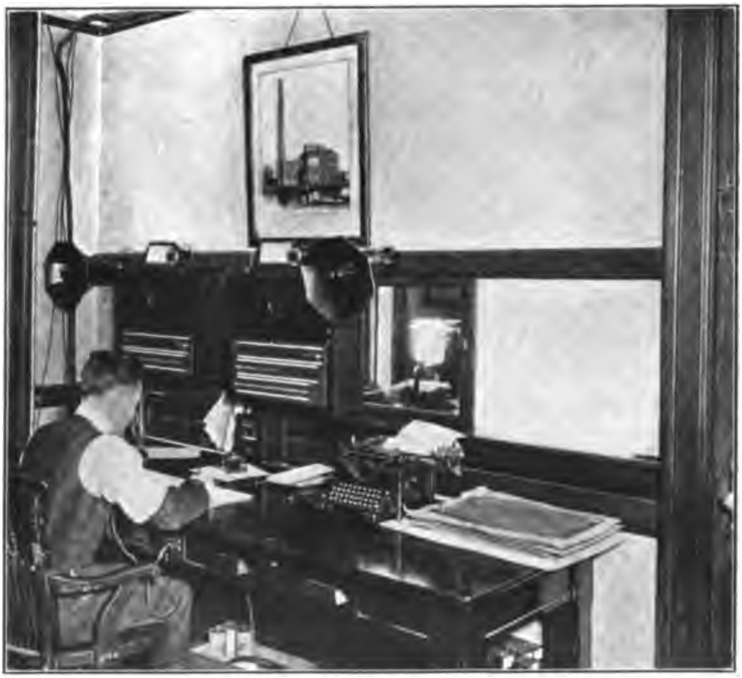


Fig. 137-8.—Automatic Switchboard Train Dispatching System.

Fig. 8 shows the Chief Train Dispatcher of the Eastern Division working at the Central Station equipment, 85 Clinton Street. Each of the way stations communicate to him by speaking into a transmitter, no ringing is required, as the Dispatcher's circuit is arranged so that if he is not listening on the line the loud speaking telephone attached to the wall speaks out the message to him and he answers by plugging in and talking on a chest plate transmitter normally worn by the Dispatcher. All train schedules can instantly be reported from each tower to the Dispatcher who can make use of this information in routing his trains.

The Dispatcher in order to call the way stations pushes a button on the cabinet in front of him representing the tower and a bell rings at that point and no other point, this being accomplished by an impulse sending device automatically sending out sixteen (16) impulses which works a selector up to a predetermined point and closes a contact, ringing a bell one second. The Dispatcher is advised that the bell at the distant point has operated by means of an answer back coil inserted in the bell circuit.

The Dispatcher can ring one station while he is talking to another station and the 110 volts going over the line is so smoothened out into sinusoidal waves that it is not loud. A special key is arranged so that the Dispatcher can automatically ring all stations on his circuit simultaneously to give common information or standard time at twelve o'clock noon.

A station at East New York wishing to talk to Chambers Street Tower, Centre Street Loop Subway, speaks to Dispatcher saying, "East New York calling Chambers," and the Dispatcher pushes the key ringing Chambers Street and then listens to the conversation between the two parties from the loud speaking horn or from the head receiver. No loss in transmission between above-mentioned points is caused by this loud speaking horn as we have introdued an amplifier into the line circuit with a new supply of battery to increase the volume of the voice similar to the DeForrest telephone amplifier which is used at four points in the line circuit between New York and San Francisco.

In the Dispatcher's circuit there is a vibrator operating continuously, the amount of current taken being almost negligible. When a station is to be called anyone of the buttons 1, 2, 3, etc., are depressed. This causes a ground to be impressed upon certain wires, which wires cause the pauses of the impulse combination to be varied. For instance, number 1 key being depressed, wires associated with contacts 4, 7 and 10 of the second set of bank wipers are grounded. Likewise, a ground is placed upon relay C, which causes same to operate. The operation of relay C allows ground to be intermittently placed from the vibrator through the back contact of relay F, the made contact of relay C, the rotary magnet of the switch to battery. The switch now rotates, making a step with each impulse from the vibrator. At each operation of the rotary a ground is broken and again made, causing an interrupted ground circuit to be transmitted to the sending relay in the Dispatcher's box, which sending relay has one side connected permanently to negative battery. The interrupted grounds from the rotary magnet are sent out, operating sending relay, as just described in regular order, excepting at such points as have been grounded on the second set of wipers by the operation of the key,. for example, key No. 1. The second set of wipers operating simultaneously with the first set of wipers passes the same contacts as the front wipers, and when the wipers come in contact with the grounded wires, due to the depressing of the key, it causes the operation of relay D which will hold back or prevent impulses from being sent from the rotary springs to the sending relay as described above. Thus the operating of the second set of wipers will hold back or prevent the operating of the sending relay when the wipers are passing over contacts 4, 7 and 10, thus it will be seen that a set code of impulses are sent which in this case would be 2-2-2-8. Other keys being depressed will cause other combinations to be transmitted. When the front set of wipers has reached contact point No. 19 it causes relay AA to be momentarily energized, which relay locks itself up from battery through its winding, the back contact of relay BB, the made contact of its own armature to ground. The locking up of this relay AA causes a ground to be placed upon the sending relay, which holds the current upon the line for the purpose of ringing a main line bell. When contact 20 is reached it simply closes the circuit again through the sending relay, which is now being held up by relay AA. The object of this contact being to allow two additional impulses to be sent to the line in case of the selection of a certain combination, and two additional impulses causing the selector to be stepped up to the second or extension bell position, this being done only when the key, indicated as second bell key, has been operated. When the 21st contact has been reached a momentary ground is again placed on relay AA, but is used only in the event of desiring a ring on a second or extension bell contact of the selector. When point 22 has been reached relay BB is caused to momentarily operate, which opens up the locking circuit of relay AA, thus dropping back the sending relay, and taking the battery for ringing off the line.

Another circuit is established from point 22 to relay F, which immediately opens up and prevents additional impulses from being sent from the vibrator; likewise it causes relay A to operate, which in turn causes relay B to operate, likewise causes the release magnets controlling the keys to be operated, restoring any of the keys 1, 2, 3, etc., which have been depressed. The operation of relay B causes the rotary of the switch to be operated at once, thus stepping same to an idle point shown by number 23. In case a wrong button has been depressed, it is possible to keep these impulses from being sent out to the line by simply depressing the push button key indicated as restore switch and keys. The operation of this key causes relay E to lock itself up, receiving its locking current from relay C, which is in locked position as long as any of the keys 1, 2, 3, etc., are operated. The operation of relay E operates relay D, preventing any of the impulses from being sent to the sending relay. Normally a very short ring is sent to the way stations, but if a long ring is desired the key indicated as continuous ring first signal is locked, which prevents relay BB from operating, thus relay AA is locked, and remains so, causing the sending relay to be operated, which in turn sends current to the line which holds the selector for ringing the bell. In order to stop this ring the first signal continuous ring key is restored and operated once in the opposite direction. This causes relay BB to operate, opening up the locking circuit of relay AA. The Dispatcher's telephone being normally across the line and circuit arrangements being made at the way stations allow the Dispatcher to receive an answer back on the line indicating to him that he is actually ringing one of the bells at a way station.

This system of communication between towers is entirely independent of switchboard operators and the Dispatcher in charge has the situation entirely under his control and by getting instant advice of a delayed train by this system permits altering the scheduled time of other trains sufficiently to equalize the time interval between trains, thus giving much better service to the public and putting the cars to the most efficient use at the same time.

On December 27th, 1915, we put into service in the Centre Street loop towers and in the Marcy Avenue tower, Brooklyn, all of which places are extremely busy in rush hours, a third system designed to meet the demand for intercommunication where the party being called is unable to leave his signal levers long enough to answer a telephone call. Instant communication of dispatching information is the result of this device as shown in Fig. 9, together with the signal cabinet and model board in Chambers Street tower. By glancing at the horn near the towerman using the transmitter and holding same with one hand and operating levers with the other hand, it will be noted that he can receive reports while at work and execute the desired trick.

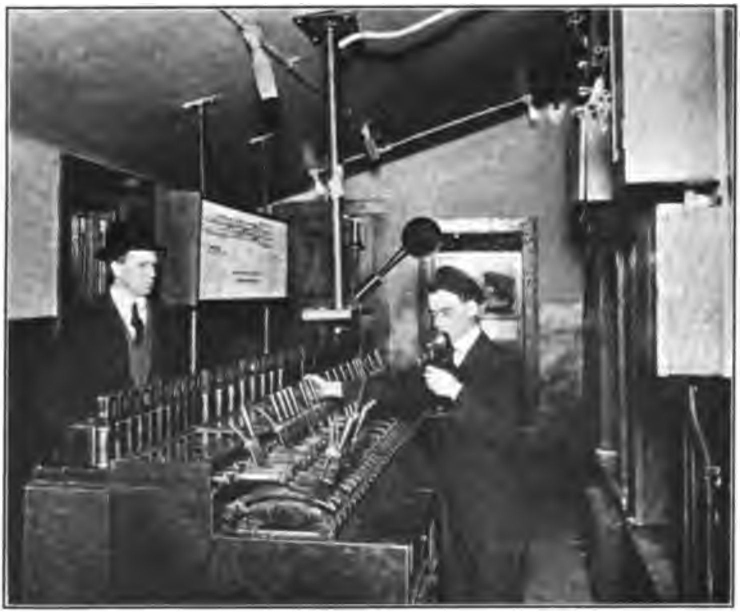


Fig. 137-9.—Loud Speaking Telephone.

All towers on this circuit hear what is said over the line and thus keep advised of the general conditions of traffic. Here again the apparatus and circuits are new and distinct advancements over earlier loud-speaking systems, as will be understood from the sample apparatus which I have set up here for demonstration purposes.

When talking into this equipment, battery is put on the transmitter by pressing a button in the stand, and the volume is considerable from each horn even with ten or fifteen horns on the one line. An auxiliary receiver is provided in cases of excessive disturbances from train whistles when it may supplement the use of the horn.

In further reference to supplemental uses to which such a novel device as this may readily be put, it may be added that during non-rush hours various selections by local talent are the usual occurrence and sometimes these afford considerable amusement among our underground lever workers, if not to the operating officials, who frequently visit the towers equipped with a loud speaker.

There are then three kinds of telephones as follows:

1. The general telephones connected directly to a switchboard.
2. The selector telephones connected together and directly to the Chief Dispatcher independent of switchboard operators.
3. The loud-speaking telephones connected to groups of closely related towers and bringing each tower constantly in touch with all others in that group.

This system is now being extended to include many other towers in the Fourth Avenue Subway, Sea Beach and other lines, as it has been found sufficient for the most exacting requirements of the towermen and dispatchers on the Brooklyn Rapid Transit system. Such instant means of transmitting orders as our loud-speaking system supplies, is certain to result in material benefits. It adds to the great combination of operating machinery one additional perfection and

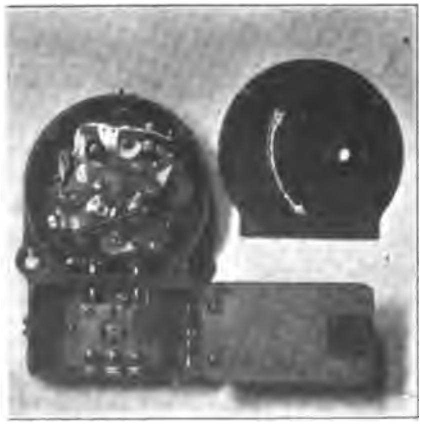


Fig. 137-10.—Emergency Alarm Box Movement.

the large number of important advancements being made by the New York Municipal Railway in all branches of its equipment. It is interesting to examine the cross-section and skeleton of the subway cars, the interior of which is now familiar to most of our people and in the plates reproduced here of this car particular attention is called to the massive fabrics of steel ribs.

In addition to all possible endeavor to render equipment, tracks, signals, speed control and construction all safe and as nearly perfect as possible, special means for the instantaneous cutting off of high voltage current from the third rails and feeder cables is generally used for underground systems, and as installed on the Brooklyn Rapid Transit lines the following description and directions for the operation of the same are applicable:

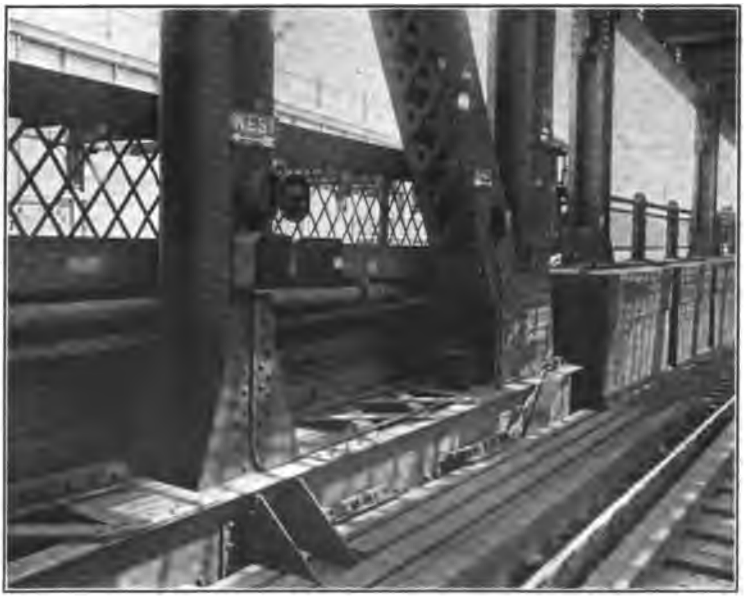


Fig. 137-11.—Emergency Alarm Box and Telephone.

For the purpose of killing the third rails in case of accident or emergency, there has been installed in the subway an Emergency Alarm System consisting of alarm boxes, located at suitable intervals, which, when pulled, will disconnect the third rails from the source of power. These boxes are located, in general, one at the head of each station platform, and at suitable points between stations at locations approximately 1,000 feet apart. The boxes between stations are located on the curtain walls between the tracks, so as to make it unnecessary for trainmen to cross any tracks in order to reach the boxes. The locations of the boxes in the subway are, in most cases, indicated by blue lights inserted in the tunnel lighting circuits.

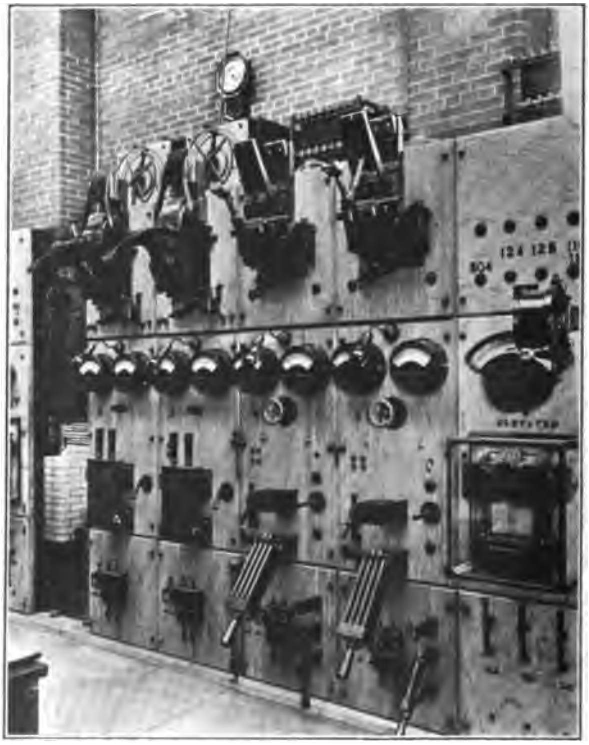


Fig. 137-12.—Circuit Breakers in Sub-Station.

Opposite each box on the outside wall of the subway is located a telephone connected directly to the company's telephone central (Clinton Street.) The removing of the receiver from the hook signals "Central"; no ringing is required.

As the pulling of any box will kill all the tracks in that section, it is extremely important that the Chief Train Dispatcher receive immediately a complete report of the trouble, so that power may be restored on the unaffected tracks as soon as possible.

Between adjacent third-rail sections two boxes are installed side by side, controlling the third rails in each direction, and in case it is necessary to kill the rail on each side of the section insulator, both boxes must be pulled.

The following general rules are to be observed in connection with the Emergency Alarm System:

1*st.* The appliances belonging to this system must not under any circumstances be tampered with, and must be used only in case of emergency, which makes it necessary for the preservation of life and property to kill the third rail. The telephones may be used, however, at all times.

2nd. It shall be the duty of any employee of the Company, observing the necessity of killing the third rails, to turn in an alarm.

3rd. Proceed to the nearest alarm box (generally indicated by a blue light), open the door, grasp the lever and pull it down until it stops, and release. Do not repeat this operation unless the rails become alive. Close the door and immediately call up the *Chief Train Dispatcher on the telephone, giving name and position, also full report as to the nature and location of the trouble.*

4th. Immediately after receiving the report, the Chief Train Dispatcher shall advise the Chief Operator of Power Stations as to cause and location of the trouble.

5th. The Chief Train Dispatcher shall notify the Chief Operator of Power Stations when power may be restored, and shall specify carefully which tracks are clear and ready for power.

6th. All employees connected with the movement of trains, maintenance of or repair of tracks, signals or power circuits, or engaged in any kind of work in the subway, must familiarize themselves with the location and use of Emergency Alarm Boxes.

The following pictures of the Emergency Alarm Equipment will show the respective parts in consecutive relation, and in case of operating the system either for the protection of the people or for the protection of the company's property, the modus operandi is shown as follows:

1. An emergency box is pulled; this sends the box number over the wire, cutting the circuit electrically. Code wheel in fire alarm box opens circuit a certain number of times according

to the box number, and causes a bell to tap each time the circuit is opened by the teeth of the code wheel.

2. Trip relays installed on the Emergency Alarm Panel units in each of the sub-stations on the circuit, opened by the operated box, release four bladed jaw switches which spring forward and close a switch which operates trip coils on circuit breakers, thereby opening the third rail circuit in the sub-stations.

3. The current passes through trip coils attached to all circuit breakers in each of the sub-stations and thus automatically open by electric power the circuit breakers through which current had to pass. For the section of subway between Bridge Sub-Station and Central Power House at this time, ten separate circuit breakers must simultaneously be opened at different points in order to kill the current rails.

4. *Recorders* wired through telephone cables and installed in the Transportation and Power Departments, perforate a paper ribbon and give a record of the box number pulled. Also a gong taps out the number audibly.

5. Special marine type telephones installed near the box locations serve the person operating an emergency box in calling up the Chief Dispatcher's Office for reporting location and cause of trouble as a part of the routine to be followed in all emergencies.

The system so far has not been utilized for emergencies of any kind and we hope it will not have to be for many years. The Transportation Department has had two recent blocks, one on February 21st between 1:05½ and 1:25 P. M., and the other on March 1st, 1916, due to some unauthorized person pulling a box. This is a feature lamentable in itself, but it is not practicable to enclose the boxes under lock, as accessibility is required, and a glass cover is not a serious enough barrier against misuse. After the newness of the equipment is over, possibly interference will be less.

DISCUSSION.

President Van Norden—The design of this equipment has impressed me very much. We little appreciate the complicated details which are necessary in the operation of the subway trains and the management deserves great credit for the high efficiency shown in the signalling system. The delays which exasperate us are relatively very few when we consider the large number of trains that are operated.

Is the system that is now installed in the subway that you refer to similar to that of the Interboro?

Mr. TRAFTON—The safety appliances are quite similar to those of the Interboro, but the telephone train dispatching is absolutely new and is designed for our special requirements. The Interboro people are coming over to inspect them to see what can be accomplished in that line, with a view to adopting them.

Mr. VAN NORDEN—I notice the phone you have is similar in appearance to those in the Grand Central Terminal.

Mr. TRAFTON—In the Grand Central they use high-voltage and here we use dry cells. Six or eight dry cells to a tower is more effective on our system than the 110 volts produced in the Grand Central. In the Grand Central you can speak on eight or ten horns, but they must be located together. In our system we have forty or fifty miles of wire on one circuit, and the resistance of the circuits is very much harder to overcome than in the Grand Central, where they are located together. Nevertheless, with six or eight dry cells on the new device which we have, we obtain better results than they do with their 110 volts.

Mr. VAN NORDEN—Is it cheaper to use dry cells than the storage battery?

Mr. TRAFTON—In all probability, yes.

Mr. VAN NORDEN—The telephone horns used at the Grand Central Terminal are not as clear as the ones we have heard tonight.

Mr. TRAFTON—No.

In answer to the question: "How is it possible to tell when the third rail has been killed after you pull that lever?" the following reply was given by

Mr. TRAFTON—There are several ways, but people prefer different ways according to their taste. Of course, if a train is nearby if the rail is dead, the emergency lights in the train are lighted, and these, being decidedly dimmer than the regular lights of the trains, give the best indication.

A MEMBER—Is there no way of telling if a train is not there?

Mr. TRAFTON—Not without some apparatus.

Then it is not altogether dangerous to touch the third rail? I have been told that it was not unusual to touch it.

Mr. TRAFTON—With good insulation, we frequently put our fingers on it. You should be careful to stand on the dry ties in touching the third rail.

BROOKLYN ENGINEERS' CLUB

No. 138

THE MANHATTAN BRIDGE PLAZA IMPROVEMENTS.

BY CHARLES N. PINCO, MEM. B. E. C.

Presented April 13, 1916.

The Manhattan Bridge is the latest of the municipal East River bridges and is so situated with respect to the Brooklyn Bridge as to enable it to help materially in the distribution of the traffic which converges into the Borough Hall district of Brooklyn and destined for the lower part of Manhattan Island. The arrangement and design of the terminals of the Manhattan Bridge were developed with a view to its utmost utility without neglecting the esthetic features of this monumental work.

These terminals being situated in a congested portion of the greater city, these improvements furnish additional traffic avenues as well as park facilities to the people residing in the vicinity of the bridge plazas.

This co-ordination in the treatment of the bridge approaches enhances their appearance and marks a distinct advance in the "City Beautiful" idea which is being inculcated so generally in most of the recent municipal planning.

Among the problems offered in the design of these approaches were to provide for the accommodation of four subway tracks, four surface car tracks, two footwalks and a vehicular roadway. All but the subway tracks were to come out at one level and maintain reasonable grades so as not to conflict with comfortable travel.

To bring about this condition the general scheme in the design was to flare the various lines of travel fan-shape at convenient levels and then assemble them at the final point at a suitable elevation. The underlying principle is practically identical for both plazas, as can be noted by comparing the general plan of each.

The area affected by the present improvement is about 10 acres for Manhattan and slightly more for Brooklyn.

As the Manhattan Bridge is a very busy traffic artery the procedure of the work had to adjust itself so as to offer the minimum resistance to the constant flow of traffic over this bridge.

and the execution of the contracts had to be planned with this detail constantly in mind.

The general subdivisions of the improvement can be classified under the following items:

I. The grading and paving of adjoining streets, including all surface and subsurface changes due to alterations of grades and lines of old established thoroughfares.

II. The construction of a two-track subway in Manhattan and a four-track subway in Brooklyn, thereby providing the closing portion of a subway system operating in the two boroughs.

III. The installation of four surface car tracks, two for conduit tracks and two for overhead trolley operation.

IV. The construction of structural steel viaducts to carry the surface cars from the upper deck of the bridge at its abutments to the surface levels beyond.

V. The construction of the masonry and concrete retaining wall to mark the present limits of the improved areas.

VI. The construction of the ornate features of both plazas, comprising a beautiful arch flanked by a colonnade and a balustrade forming a gateway in Manhattan and two impressive pylons in Brooklyn, all this work being done in light colored granite and supplemented with carving and statuary.

VII. The available areas within the exterior walls were laid out into park spaces and embellished with walks, trees, shrubbery, etc.

The general treatment of the Manhattan end is centered about the arch and its colonnade. The arch is placed transversely to the main roadway of the bridge and about 200 feet from Canal Street. Extending to either side of the arch is the elliptical colonnade symmetrical with the axis of the roadway. Beyond the colonnade is a light balustrade wall completing the ellipse and thereby making a mouth, or entrance, for vehicular traffic to the bridge. This entrance is located on Canal Street about 100 feet east of the Bowery, the latter street marking the westerly limit of the Manhattan plaza. Within the ellipse is located a safety island, and on the inner border of the ellipse is placed a footwalk reaching from Canal Street to the base of the arch.

Three hundred and fifty feet behind the arch will be found the bridge abutment, and a cross section at this point shows at the lower level a 35-foot roadway at the center. On either side are two subway tracks, making four in all, and on either outside is a 10-foot walk. On the upper deck of the bridge, directly over the subway tracks, are located two surface car tracks (four in all) on either side of the roadway.

The four subway tracks maintain a grade slightly over five per cent from the abutment. In this proximity they are located in an open cut which extends to a point 80 feet behind the arch, where is situated the portal to the subway proper. The subway then cuts through the arch foundation and then deflects to the left, entering Canal Street near the Bowery, joining the city subway system at this point.

The four street car tracks leave the bridge at the abutment on the upper deck level. The two conduit tracks occupy the easterly viaduct and the overhead trolley the westerly one. The conduit tracks are carried on a viaduct to the subway portal behind the arch, coming off the elevated structure at the roof level of the subway and following around a concentric alley behind the colonnade to Chrystie Street and Canal Street, and thence continuing westward. The overhead trolley system, which handles the local bridge traffic, is provided with a terminal adjoining the exterior wall on Bayard Street. (See general plan.)

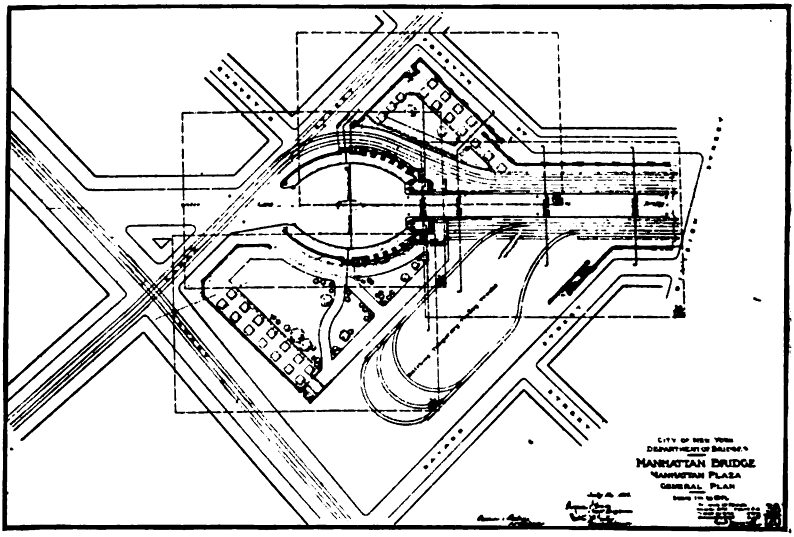


Fig 138-1.

Beginning at the abutment the footwalks are carried on the fill behind the exterior retaining walls and are terminated with granite stairways for convenient access to all the boundary streets. The areas within the walks are sodded and stocked with a number of trees and shrubs.

The Brooklyn plaza is similar to the Manhattan one except in the detail of the arch and colonnade, for which are substituted two granite pylons used to mark the gateway to the bridge. An added feature to this plaza is the large flag pole which is located on a safely island and adds considerably to the vista visible from Flatbush Avenue, the main approach street to the bridge. (See Brooklyn plan.)

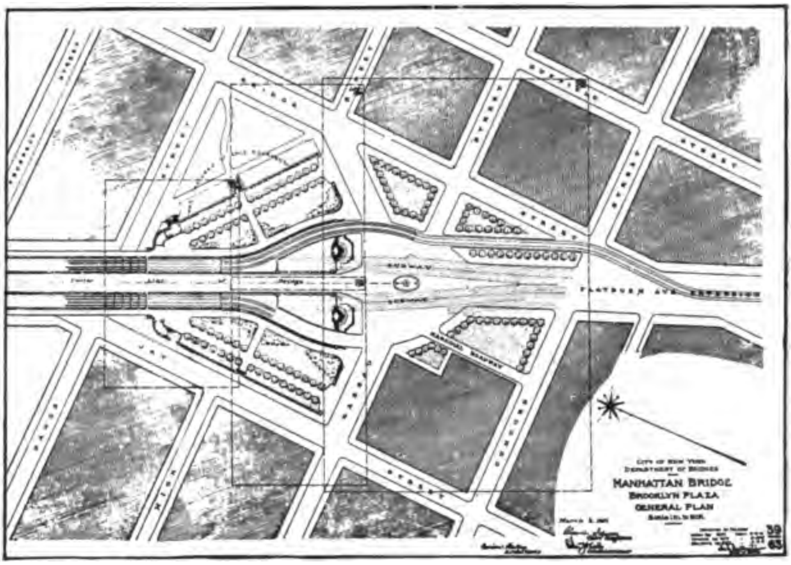


Fig. 138-2.

The design and construction of this work was done under the supervision of the Bridge Department, with the co-operation of Carrere & Hastings in the capacity of consulting architects.

Ground was broken in Manhattan early in 1913, and about six months later in Brooklyn.

In order to maintain desirable grades for the easterly subway it was necessary at the New York end of the bridge to raise the street level at Canal and Chrystie Streets 8.8 feet above its old elevation. This change affected not only the house frontage, but

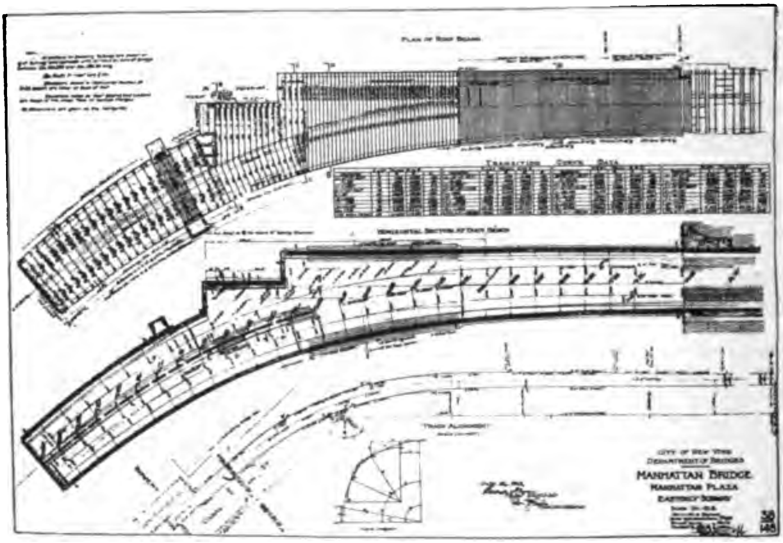


Fig. 138-3.

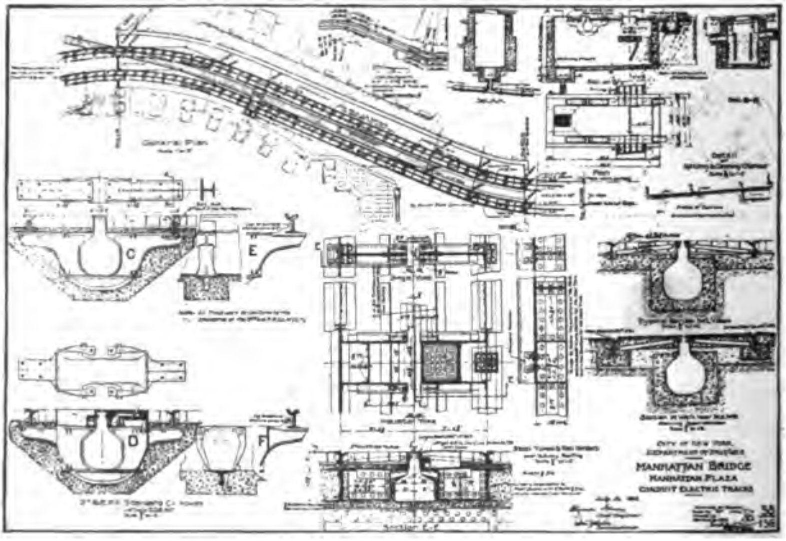


Fig. 138-4.

also the street surface and sub-surface structures. It involved a rearrangement of the sewer system and manholes, the high and low pressure water mains and hydrants, gas mains and their gates, electric service conduits, sidewalk vaults and ovens, lamp posts, and the usual store fronts and stoop changes. Needless to say, all this manner of work had to be done with a minimum interruption to service, and it was successfully carried out on both sides of the river with very little discomfort to the occupants of the property adjacent to the site.

In the desire to bring about normal street conditions with the least amount of delay the easterly subway in Manhattan was built simultaneously with the filling of Canal and Chrystie Streets, the contractor using an electric travelling derrick for hoisting hand-filled buckets of excavated material and draying same to a suitable site along the street. This material was placed in layers, wetted and ridden over, and resulted in a very suitable fill, and at the present time (more than two years aftter being placed) shows no noticeable settlement. Previous to carrying the fill to the house lines the affected property was either raised to its new sidewalk grade or a retaining area wall built up and the fill placed compactly up to it. Any of the old water mains to remain in service were raised with the assistance of wooden horses, from which were suspended large screws carrying chains, so that when the threads were taken up an entire section of water main was lifted gradually enough to maintain the tightness of the caulked joints. This proved a satisfactory and expeditious manner for doing this work. The high-pressure water mains were covered with 5 feet and the low-pressure with 4 feet of fill. All the other services were covered with about 2 feet of fill.

The subway from the arch west was built in open cut, the earth banks being retained by 3-inch timber sheeting with bracing extending to opposite wall, which were generally spaced 28 feet on centers. The excavation of that portion which was located within Canal Street was made possible by diverting the main bridge roadway to the south, thereby leaving Canal Street between Chrystie Street and the Bowery free from vehicular traffic, an entrance to the bridge being provided on the Bowery just south of the southeast corner of Canal Street and the Bowery. All surface cars prior to the completion of the east subway were run over the westerly portion of the bridge. With the demolition of the houses located on the extended center line of the

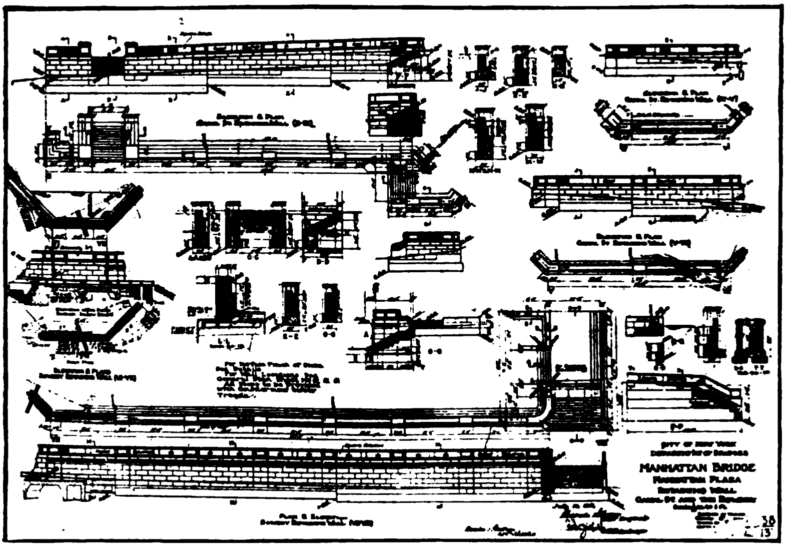


Fig. 138-5.

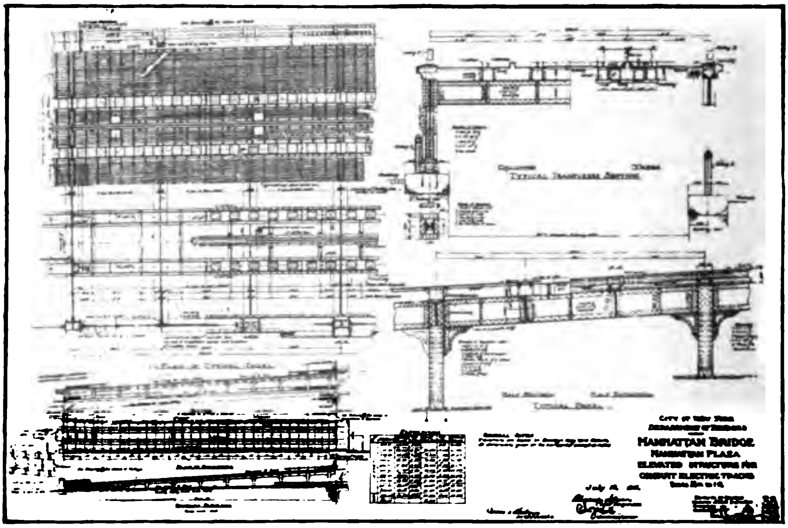


Fig. 138-6.

bridge added sidewalk area was obtained on the north side of Canal Street.

The easterly subway, which was built under the present contract, is parallel to one built a few years ago west of the roadway and is about 750 feet long, representing in that short distance six distinct types of subway construction. Beginning at the abutment (sta. 5+96) the subway is in open cut, with concrete walls on either side, capped with granite coping, which carries the elevated structure. This type of construction is typical to the subway portals. Then we have a steel column wall encased in concrete, with roof beams and roof arch construction. These carry the conduit electric tracks and a platform. Beyond this the subway cuts through the arch foundation with heavy steel grillages and columns around it and then continues for a short length with reinforced concrete walls capped with roof I beams to carry part of the elliptical roadway. This is typical to Canal Street, where wall columns on grillages and roof girders are required on account of the span and loading. At this point in the curve a prospective spur connection is provided by a jog in the northerly wall of the subway. Passing this point and directly under Canal Street a center wall construction is used, thereby reducing the roof span and thickness, and again using reinforced concrete side walls and encased center wall columns on grillage footings. The line deflection is laid out to conform to a transition curve. This brings the subway to station 1+49, where it is joined by another section.

The Brooklyn subways are placed on either side of the main roadway and extend from the abutment to Nassau Street, each about 475 feet in length. These are typical in construction to the Manhattan side.

The surface car tracks lead from the upper deck of the bridge at its abutment over a structural steel viaduct of typical design. The columns rest upon the granite coping of the subway walls, and each column footing is anchored into the subway coping with four 1¼-inch fox bolts. Each column base is leveled to conform to the slope of the coping, which for column bases is dressed to six cut. The bolt holes in the granite are eventually filled with grout after the bolts are tightened to insure proper bearing for base plates. The panel spacing for the viaduct is twenty-seven feet on centers longitudinally for columns, with an expansion provided every three panels. The elevated structure

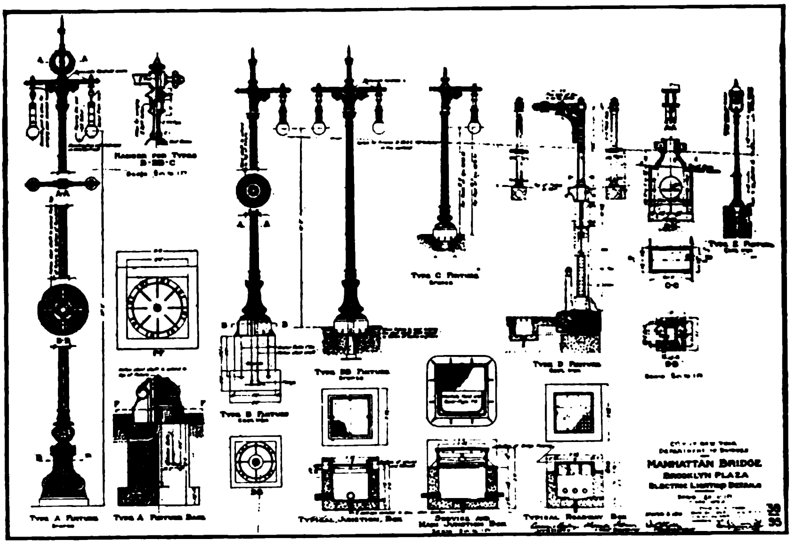


Fig. 138-7.

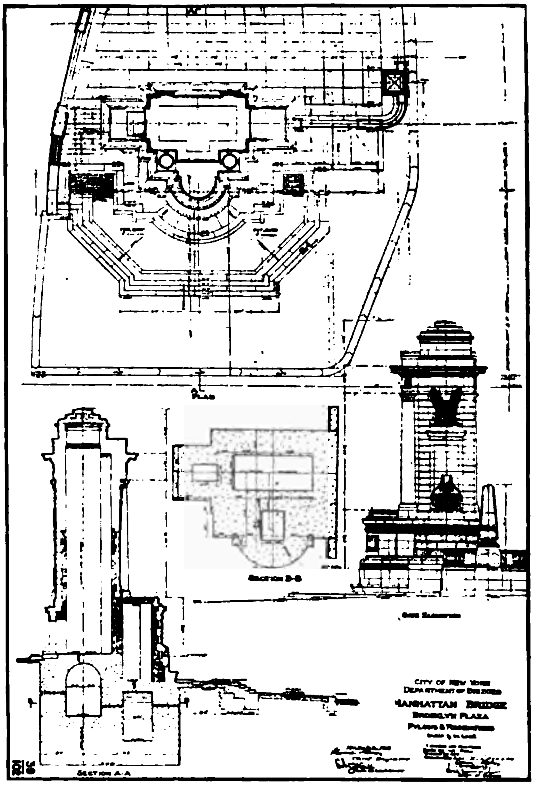


Fig. 138-8.

is spaced twenty-eight feet on centers transversely and carries two tracks and a floor of bar gratings. The floor level is finished off on either side of the structure with an ornamental fascia girder which is topped with a metal railing. The grade of the track is nearly six per cent. Beginning at the subway portals there is a change of alignment to go around the colonnade in Manhattan and the pylons in Brooklyn.

In order to meet the general levels of the plazas it was necessary to provide retaining walls to permit the tracks to descend to the street levels. These retaining walls are of reinforced concrete with granite facing and are typical in construction with the exterior walls which extend around the improvement. These walls vary from 36 feet in height at the abutment to 6 feet, and of corresponding thickness and depth of foundation. As most of the walls are situated on the sites of old cellar bottoms, great care was given to the matter of making sure that the wall footings were placed on firm ground. A large number of old vaults, abandoned house drains, coal shutes, etc., were found with the help of test pits and water jets. These precautions were very essential where virgin soil was not obtainable at the planned sub-grades. Occasionally footings would be carried to a greater depth, but rarely with any added spread. In order to minimize the effect of movement due to expansion and settlement expansion joints were placed vertically in the walls at 27-foot intervals generally, and consecutive wall sections were keyed into each other. The end of each finished section was painted with hot paraffin before the next section of concrete was poured. At the extension joints the ashlar facing was laid up with very weak mortar so as to permit of easy sliding. This method of providing for expansion proved satisfactory.

The front of the wall was set on a scotia base course. The wall was panelled with rustication and topped with a heavy cornice surmounted by an ornamental balustrade, all of pink-gray granite from the Stonington, Maine, district. The wall was subdivided with pilasters.

The types of cutting used on the exterior wall were rough pointing and pean hammering, with the pilasters in the more rugged style, giving large stretches of the wall a very effective appearance. The average dimensions for stones in the wall were five feet for stretchers, with a two-foot rise, and extending two to four feet into the wall. A sufficient number of headers were

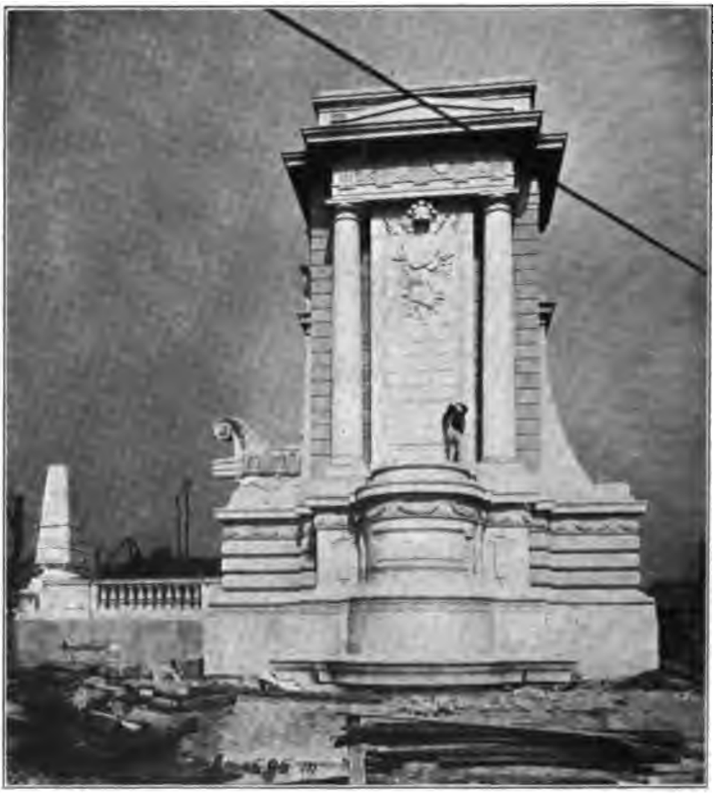


Fig. 138-9.—East Pylon, Front View—Brooklyn.

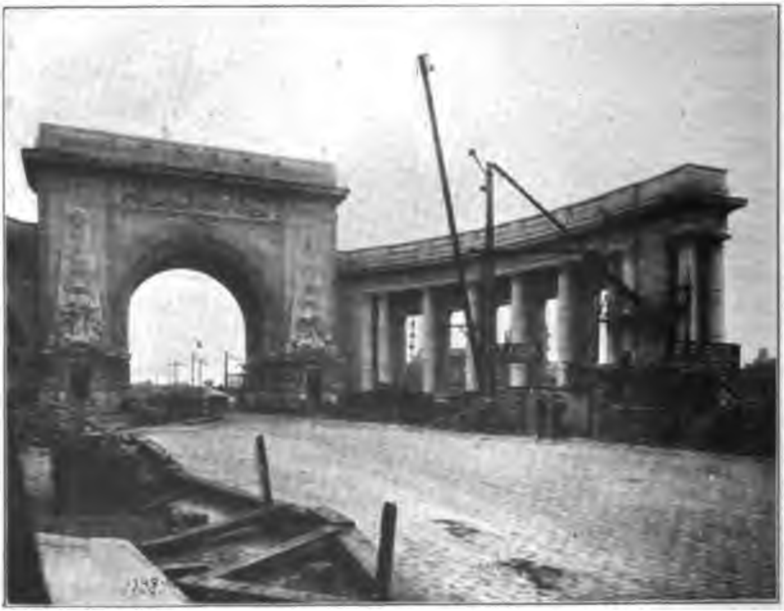


Fig. 138-10.—Arch and Main Roadway—Manhattan.

used in the ashlar face to bond the backing with the granite. The baluster was made of a baluster base, square cut balusters and rail and stands a little over three feet in height. During the setting the various parts were properly cramped and doweled. The balustrade panel spacing was maintained by die-blocks and newels. The stairways were made of reinforced concrete slabs topped with granite steps faced with safety treads.

Most of the granite setting was done by large stiff-leg derricks with seventy-foot booms and operated so as to enable the concrete backing to be placed simultaneously with the granite setting in alternate sections.

The rear of the wall, which was of concrete, was stepped off in sections, waterproofed with three layers of Hydrex or five layers of felt, burlap and tar, and covered with brick backing for protection against the fill. The waterproofing was placed only between the sidewalk and coping levels.

On the Manhattan side the concreting was done mainly with half-yard Chain belt mixers. The average plant in use consisted of three or four large derricks and several jinny-winks for the granite and steel erection and two to three mixers for the concreting. In Manhattan these were electrically operated. In Brooklyn they were operated by steam.

The cost of shifting roadways ran into considerable expense, for at all times a roadway of twenty feet minimum width was maintained. The roadway surface was made of two layers of planking cross laid resting on sleepers and bordered with a wooden curb and a stout fence. It might be well to state at this time that a traffic count showed that in 1915 there were 111,000 people, 2,500 cars and 9,400 vehicles crossing daily over the Manhattan Bridge.

The arch and colonnade are easily the most impressive features of the plaza improvement. The arch is semi-circular and 36 feet 6 inches in span. The outside dimensions at the base are 81 feet across the face and 37 feet 9 inches from face to rear. It is approximately 70 feet 6 inches from the roadway level to the parapet of the roof. There is an entrance to either arch leg and stairways to the various levels, including an exit to the roofs of the colonnade and arch. The soffit of the arch is decorated with rosettes and borders and required the most skillful and painstaking setting. The individual stones (voussoirs) were set

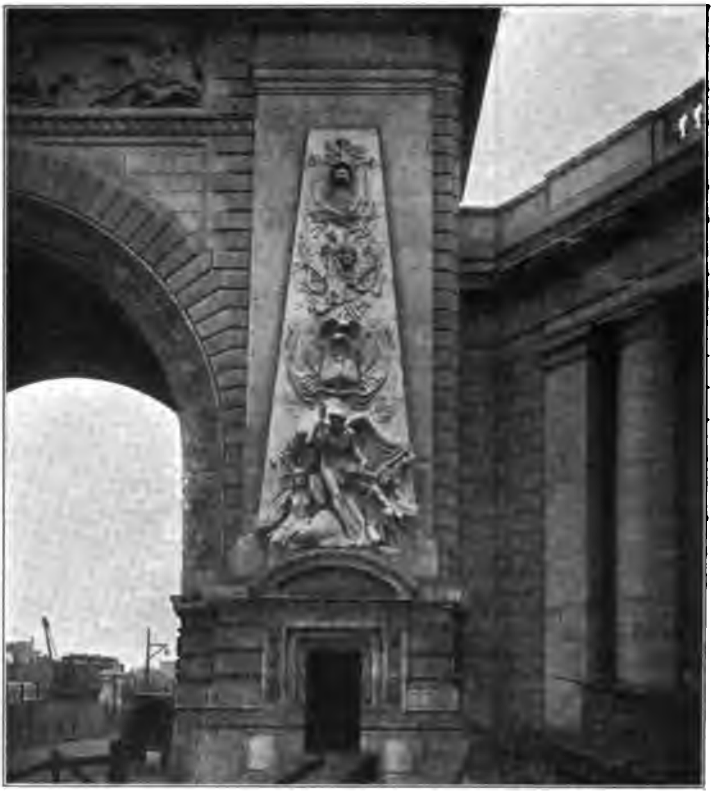


Fig. 138-11.—West Pylon, Front Face of Arch—Manhattan.

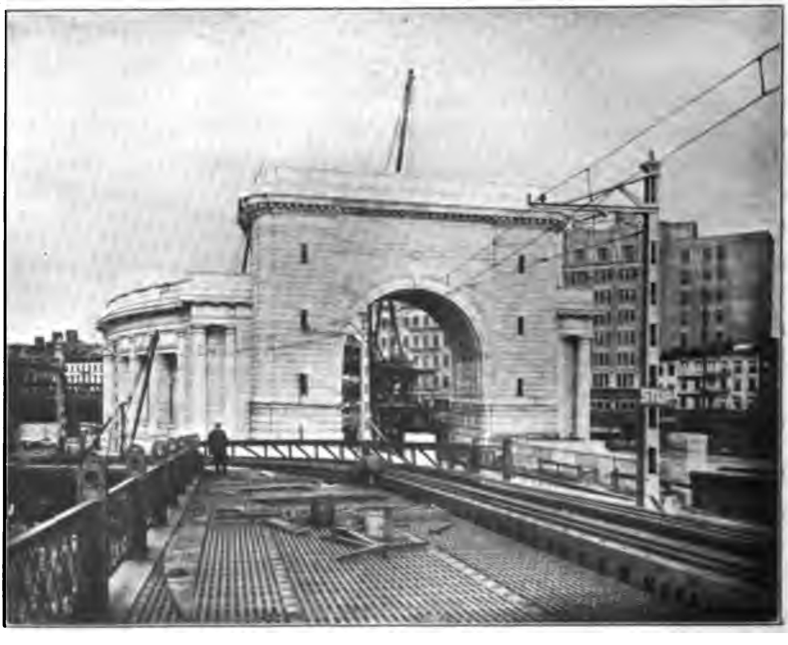


Fig. 138-12.—Rear of Arch and Colonnades—Manhattan.

on small hard wood blocks against the lagging and the position of the arisses were maintained from the face rings. In the beginning the face rings were set from a theoretical center located on the false work and checked from the haunches for elevation and position. It was found unnecessary to protect the projecting portions of the rosettes.

As the arch centering, consisting of eight ribs resting on six bents, was supported at both ends and the middle and these supports carried to pockets cut into the concrete footing of the arch at the sides, very little settlement was noted in the centering. A mass of concrete was placed in the back of the arch ring to induce equilibrium. A sufficient number of voussoirs were cut as headers to bind the concrete covering of the arch. The centering was carried on hard wood striking wedges, resting on caps supported by two diagonal posts at the center in "A" frame fashion and end posts near the haunches of the arch. This arrangement made it possible to keep the main roadway open to traffic. The shifting of the stone for the arch rings and spandrels was done by a stiff-leg derrick supported by a timber trestle and placed over the roadway to clear vehicles.

The arch piers have two entrances. These are capped by carved pylons and statuary groups extending to the level of the crown of the arch. On the front spandrel for the entire span is placed a frieze panel carved in bas relief and representing a buffalo hunt. This panel is 40 feet long and 7 feet high. The pylons are about 36 feet high and 10 feet wide at the base. All the faces of the arch are highly ornate. The models for the carving and the statuary were made by some of the best sculptors in America.

The colonnade joins the arch legs on either side and extends in elliptical shape for about 100 feet from the arch. The colonnade consists of a series of Tuscan columns and pilasters topped with a frieze of carved panels and a heavy cornice surmounted by a balcony. The granite used for the arch and colonnade is a light gray granite from quarries of the Hallowel Granite Company at Hallowel, Maine.

The granite in the hollow portions of the masonry was brick backed and buttressed where necessary, and a suitable number of anchors and cramps were placed to insure secure bedding of the stones. The pointing was done with a mortar consisting

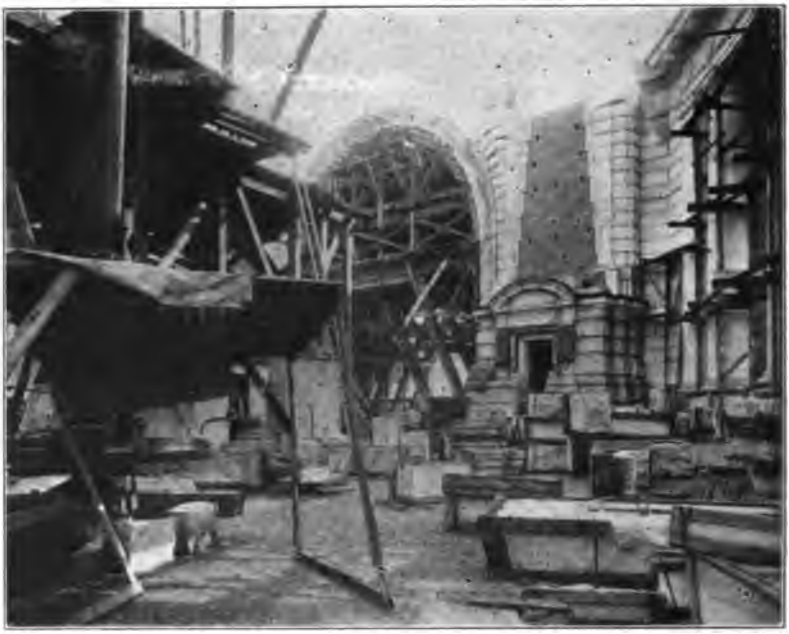


Fig. 138-13.—Arch Ring and Falsework—Manhattan.

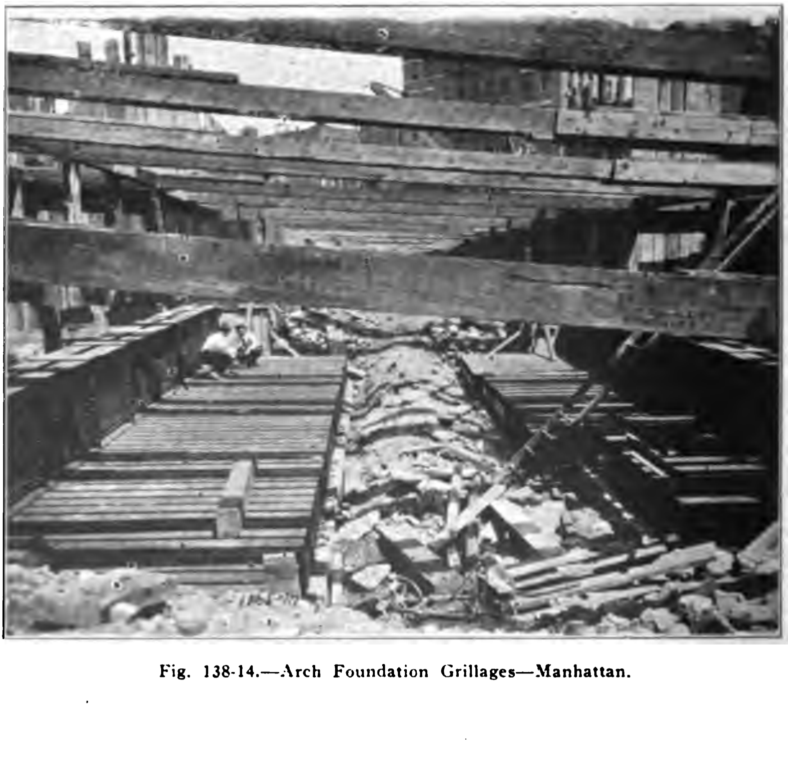


Fig. 138-14.—Arch Foundation Grillages—Manhattan.

of white portland cement mixed with white beach sand. The surface cutting generally was 10 cut; however, certain architectural effects required standard and coarse rough pointing, pean hammering and fine pointing. The contractor was required to submit samples of these grades of cutting for field comparison The stone was shipped carefully crated to avoid breakage and staining. The jointing throughout this class of work was to be three-sixteenths of an inch. The balusters and rails were brass doweled.

The granite pylons are the ornamental features of the Brooklyn plaza and are located symmetrically with the roadway. These pylons are built of Victoria white granite and stand 75 feet in height and 40 feet in width at the base. The façade has a projecting semi-circular platform, upon which is placed a large statuary group. The pylons show additional ornate treatment, as can be seen from the illustration. The pylons are hollow, and one of them contains the switchboard for the lighting system of the plaza. A similar arrangement is used in Manhattan in regards to the arch.

Behind the pylons is a platform which has a granite slab pavement bordered by an ornamental granite balustrade whose newels are capped with obelisks.

At the vertex of the radial street intersections is placed a safety island having at its center a large wooden flagstaff made of a single stick of Douglas fir measuring 24 inches in diameter at the butt and about 100 feet in length. The base of the pole is set in a Tiffany bronze casting resting upon a concrete foundation.

The available areas within the exterior walls of the plazas are sodded and the walks and lanes are bordered with shrubbery and trees. Three types of walks are used. In Brooklyn bluestone flagging and cement walks were laid. In Manhattan cement walk was placed in some parts and gravel in others. The park areas were provided with street washers for water supply. Suitable lighting and drainage systems were installed.

The specifications for construction are practically identical for both plazas. Some of the quantities of materials used in connection with these improvements may be of interest and are as follows:

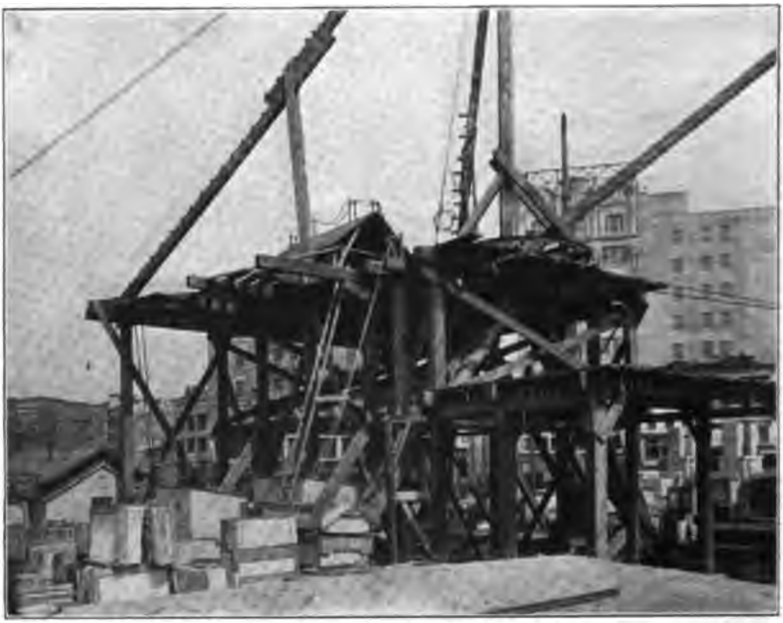


Fig. 138-15.—Derrick and Platform for Arch Construction—Manhattan.

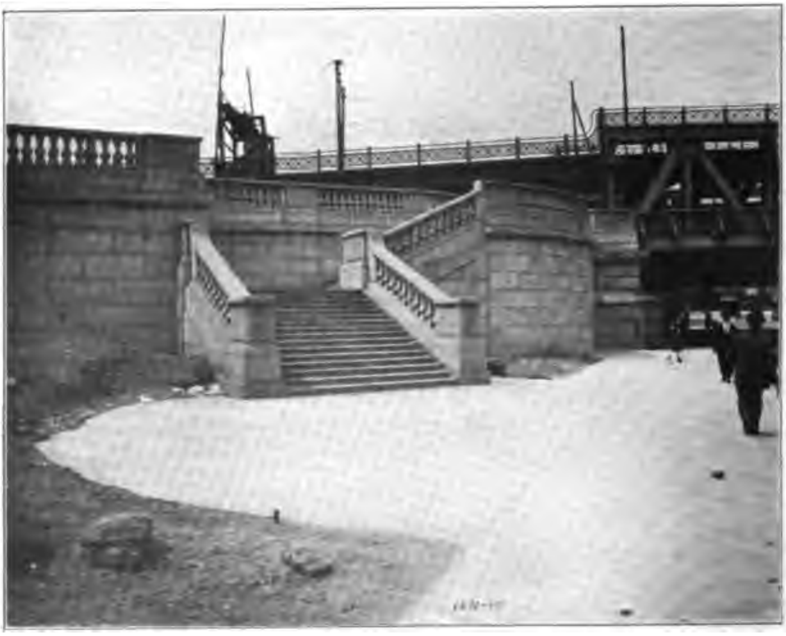


Fig. 138-16.—Sands Street Stairway—Brooklyn.

Items.		Manhattan.	Brooklyn.	Total.
Excavation	cu. yds.	20,000	20,000	40,000
Fill	cu. yds.	25,200	23,000	48,200
Structural steel	tons	1,200	800	2,000
Concrete	cu. yds.	14,500	11,500	26,000
Granite (exterior walls)	cu. yds.	1,950	1,750	3,700
Granite (arch, pylons, etc.)	cu. yds.	3,050	1,150	4,200
Waterproofing	sq. ft.	58,000	48,000	106,000
Brick masonry	cu. yds.	1,500	800	2,300
Paving	sq. yds.	7,700	13,500	21,200
Walks	sq. ft.	80,000	80,000	160,000

In addition to the above, the other large items included in these contracts were the track work, sub-surface electric conduits, drainage, water supply and lighting system, metal railings and the parking. The specification provided for one hundred and twenty-nine different construction items for Manhattan and seventy-nine items for Brooklyn. The specifications for the surface and sub-surface work on the highways required that these items be done in conformity with the requirements of the various interested City Departments.

DISCUSSION.

Mr. F. W. Perry:—The author has given in some detail, an idea of the plans for constructing the plazas of the Manhattan Bridge over the East River in so far as the physical features of these plans have been determined and the structures built.

His descriptions and the photographs and plans he has shown faithfully represent the work that has been done in the spaces that had been acquired by the City at the ends of the bridge to provide for suitable entrances to the bridge.

He lived on that work from the beginning until well along toward completion in "cheek by jowl" fashion—the speaker would add—in season and out. Mr. Joseph R. Geoghan was in immediate charge of the work on both plazas, at the outset Mr. Pinco assisting on the Manhattan Plaza and Mr. Carl T. Forsberg on the Brooklyn Plaza.

Our idea of beautifying the ends of the approaches of these great over-river highways comes from abroad. The bridge proper terminates, in general, where the grade of the approach

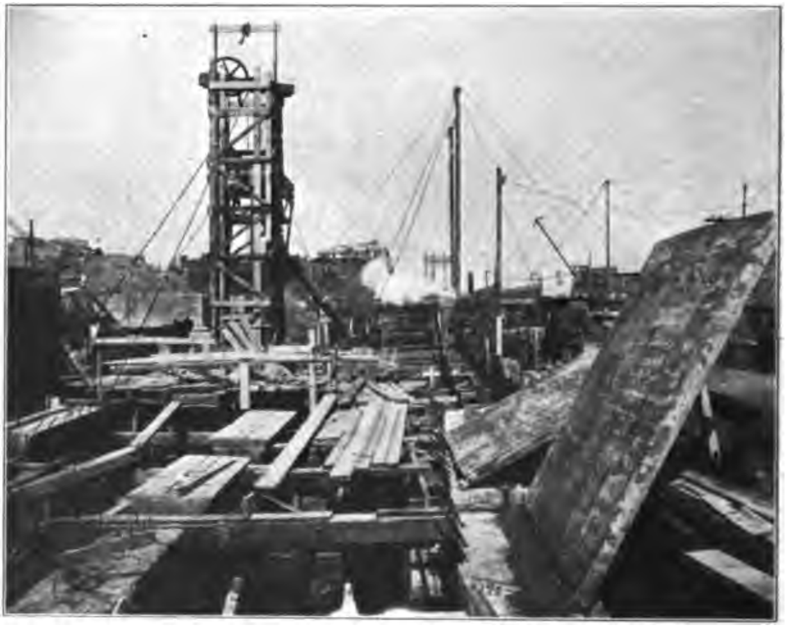


Fig. 138-17.—Concreting Plant, Westerly Subway—Brooklyn.

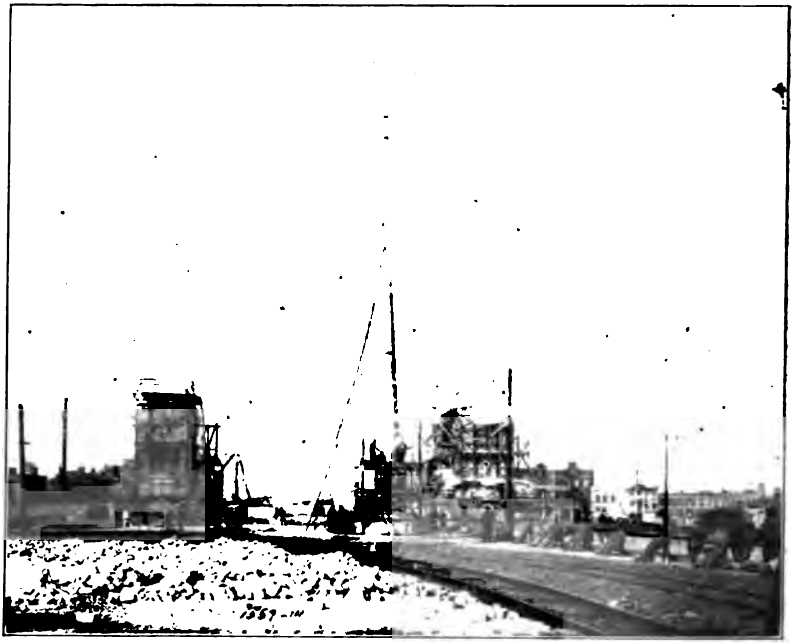


Fig. 138-18.—"Shear Legs" for Erection of Flag Pole—Brooklyn.

intersects the grade of the street crossing at the front of the bridge. Thus, Brooklyn Bridge—the oldest of the East River bridges—originally fronted on Sands Street in Brooklyn and on Park Row (then Chatham Street) in New York. Similarly, Williamsburg Bridge, next in point of time, originally fronted on Clinton Street in New York, but in Brooklyn a new street was laid out crossing at the front, beyond which a plaza was laid out extending to Havemeyer Street.

The ends of the bridge in each case were marked with simple terminal posts. Later, at Brooklyn Bridge immense train sheds were erected over the end of the New York approach and just beyond the end of the Brooklyn approach, and train storage yards were carried still further into Brooklyn easterly to Tillary Street. These were necessary for the operation of the bridge railway, which since the year 1907 was "scrapped" and the track, shed and yard facilities on and in connection with the bridge have been operated under lease arrangement in connection with the elevated railway lines in Brooklyn.

There is a very general desire of the people of Brooklyn to have a plaza in place of these obsolete railroad facilities at the oldest gateway to Brooklyn, and plans to that end have recently been put forward. A feature of these plans is the entire elimination of elevated railway tracks from Fulton Street below Adams Street, the track connections with the Brooklyn Bridge to be made through Adams Street and via private right of way to the site of the present train shed, where a modern station is proposed to be constructed.

More recently, however, came the so-called Dual Subway System, the immediate effects of which on the traffic which will come to Brooklyn Bridge after its operation has been commenced, can hardly now be estimated.

We have considered with the author of the paper read tonight the possibilities of treatment at the ends of a bridge where the rapid transit lines are carried into subways. Beyond the Manhattan end of Williamsburg Bridge a similar condition exists, but a purely esthetic treatment was not attempted here. The entire surface area was needed to adequately provide for surface traffic in front of the bridge and for entrance and exit facilities of the depressed railway station and trolley terminal which occupies the sub-surface area. Shelters were built over the stairways leading to the station and terminal, and the design of these is in harmony with the neighborhood buildings. It contains no expression of the proximity of a bridge thoroughfare to Brooklyn.

A like treatment would be possible where neither subway nor elevated railway tracks cross the plaza. Such a case was presented at Brooklyn Plaza of Williamsburg Bridge. Here the entire surface was metaled and the utmost provision made for street traffic, including the surface car lines of Brooklyn and Manhattan. Subsequently an elevated railway was built diagonally across the plaza, connecting the bridge with the elevated railway on Broadway. Now the railway company proposes to build a three-track elevated railway station which would replace the present diagonal connecting tracks. No comprehensive treatment yet has been possible at this plaza for the reason that the utilities to be accommodated have not been determined. The bridge has been in use since the year 1903.

At Manhattan Bridge the use of all rapid transit tracks has been fixed; they connect with subways at both ends.

At Brooklyn Bridge it would seem that the third tracking of the Fulton Street elevated line and the proposed Adams Street railroad and enlargement indicate a continued elevated railway service over this route. By this plan the yard would be eliminated, the shops doubtless would go (these adjoin the yard and were built and equipped to repair the locomotives and cars of the bridge railway as it existed prior to about the year 1908 and for bridge repairs), but the new Sands Street station would screen the bridge entrance from view along a line parallel with Washington Street, with the result that any monumental treatment would be somewhat detached from the structure to which it should bear an intimate relation and thus exist as an absurdity. Most likely the space now occupied by the yard structure would be developed conventionally as a simple park—largely grass, some trees, and benches.

Moreover, a distinct advantage of the plazas of Manhattan Bridge is their location on the straight center line of the bridge, which runs through them, and permitted the arrangement of symmetrical architectural groups on the plazas so that the elevation of the superstructure of the bridge as seen from the end rises in the view through these groups.

No such desirable condition is possible at Brooklyn end of Brooklyn Bridge for the reason that between York and Prospect Streets the line of the bridge curves sharply to the south from a direction approximately parallel with lower Fulton Street to a direction parallel with Washington Street. Thus, instead of Brooklyn Bridge the Brooklyn tower of Manhattan Bridge is seen, located at the foot of Washington Street, looking through the site of a gateway.

Of course, if the Fulton Street elevated railway is to end somewhere uptown and the trains be run into a subway, and eventually no trains will come to Brooklyn Bridge by any elevated route, only when that comes to pass will there be any possibility of definite consideration being given to a proposal for a monumental gateway at the old bridge.

There are some who will say that the esthetic treatment of bridge plazas along the lines of embellishment adopted for Manhattan Bridge ought not be attempted at the Brooklyn end of Brooklyn Bridge. In the speaker's view, the fact that Brooklyn Bridge is located on a line joining the governmental center of the city with that of one of its greatest boroughs, and with the bridge limits in these centers, and the further fact that there is no suitable crossing for a bridge below it in Manhattan, are strong indications that there will always be a bridge at this crossing and that some expression of the civic character of the over-river highway between these centers in the shape of gateways to the bridge, is inevitable.

BROOKLYN ENGINEERS' CLUB

No. 139

THE WATER-PROOFING OF STRUCTURES SUBJECT TO STRESS FROM LOADS AND TEMPERATURE VARIATIONS.

By Albert H. Rhett, B. E. C.
Presented May 11, 1916.

The problem of the preservation of engineering structures was first imperatively presented to me in 1910, in connection with the design and construction of the structures of the New York, Westchester and Boston Railway Company, and the interest aroused at that time has continued to grow with the realization of the importance and scope of the problem.

Now it is an interesting fact that while water is one of the prime elements of growth in organic life, it is the prime element of decay and disintegration in inorganic life, either in conjunction with the oxygen of the air or as the conveyor of some chemical element that reacts destructively with the materials with which it comes in contact.

It is practically true that every particle of inorganic material in existence today, which is in contact with water or moisture, is undergoing disintegration, and when these materials may be the component parts of such structures as the Hell Gate Bridge, the Woolworth Building and the Grand Central Terminal, this prospect is not pleasing to engineers responsible for their design and permanence.

The preservation of any structure becomes, then, the problem of water-proofing it, speaking broadly, or more specifically, of protecting it from the reactions of water with elements existing in the materials themselves or in the surrounding medium. The means best adapted to the protection of a structure of wood are not, necessarily, the ones best adapted to the protection of a structure of concrete or steel, while even with a given material, the proper medium for its protection under one condition of temperature or atmosphere may not be the best for its protection under another.

The service to which the structure is to be put, moreover, may have an important bearing on the subject, because the physical disruption and destruction of the protective medium by stresses acting in the structure, may be a prolific cause of failure, and provision in regard to this element may prove of prime importance. A method that may be efficient for the protection of a foundation or sub-surface structure that is subject to hydrostatic pressure but not to vibration or temperature variation, may prove absolutely worthless when applied to the protection of a structure that is subject to both vibration and temperature variation, as a railroad bridge floor.

It would thus appear that the very vital problem of the protection of the great structures that are being built today is quite a complicated one, and that it is dual in nature, being both chemical and structural. In fact it has become so important and at the same time so complicated and technical, that it would seem that a new field of engineering endeavor is calling; that of Protective Engineering, and that to be properly equipped for it, one must have a scientific training in both chemistry and structural design.

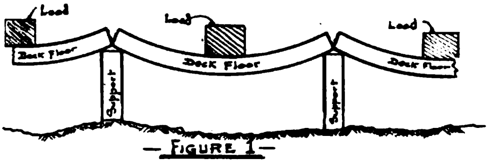
It is, however, of but one feature of this broad subject that the present descussion treats and that is the water-proofing of structures subject to stress from moving loads and temperature variations. This is, though, without doubt, the most annoying special problem in the entire field of water-proofing and it is pretty generally acknowledged that but few structures of this type that are water-proofed, are *literally* water-proof. In fact the Bridge Engineer of one of the largest railroad systems in the country recently remarked to me that he did not really have a "tight" bridge on the road and that he did not believe it was possible to make a really water-proof bridge floor. This seems to be a somewhat exaggerated and pessimistic view to take of the subject, but it is indicative of the general feeling among engineers in regard to it.

The importance of literally water-proofing some of the structures of this sort presents itself under two aspects, both of which are more or less imperative. The first and most important, of course, is the protection of the structure itself from disintegration, but by far the most obvious and annoying is the protection of the space covered by the water-proofed area. When this space is a street crossing, occasional drippings, though annoying, may not be prohibitive; but where, as in many of the new big railroad terminal developments, it is baggage room, waiting room or station concourse, even occasional drippings are not permissible.

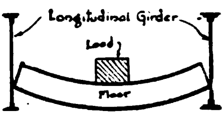
Now, while the causes of leakage in this type of structure are quite simple of analysis after they have once been discovered, it has taken many failures and much sad experience to bring this out. It will make for clearness, however, to start with this analysis so that the cause of trouble may be kept in mind as the progressive steps taken to correct them are traced through to what we believe is a practical and rational solution.

The surface to be water-proofed is practically in every case concrete, so that the porosity of the concrete may be considered as the first cause of leakage.

A second would be the inevitable breakage of the concrete from temperature variations, as this type of structure is nearly always subject to considerable range of temperature.



—FIGURE 1—



—FIGURE 2—

A third cause of trouble is illustrated in Figure 1. That is when a multiple span structure is subject to load, the deflection of the span and the immobility of the supports gives rise to tension in the upper fibres of the spanning beam, at the supports, and consequently in any concrete covering or surrounding it, causing breakage of the concrete at these points.

Figure 2 illustrates another cause of trouble which has proven to be the most difficult of all to correct and at the same time one of the most dangerous if left uncorrected. This is the breaking away from its supporting girder of the floor, in through girder construction, due to the deflection of the floor when loaded. It can be readily seen that this may be the means of introducing water directly to the floor beam connections.

These two latter defects would not give rise to any especial difficulty if the load were fixed, but where it is a moving or recurrent one, these breaks will open and close with each passing of the load and it this feature that has made these two prime causes of trouble the most difficult to overcome. This alternate opening and closing is also, of course, characteristic of the temperature cracks, but here the process is not so violent.

To solve successfully, then, the problem of water-proofing the floor of a structure supporting a moving load and subject to wide temperature variation, it will be necessary to provide some means to correct these four causes of trouble, namely:

(1). Porosity of the concrete.
(2). Breakage from temperature variation.
(3). Breakage over supports.
(4). Breakage at juncture of floor and supporting girder in through girder work.

Of course there is an element in the problem that precedes the actual water-proofing of the floor and that is the removal of the water from it as soon as possible, and this feature must be given prime consideration in design. It will not, however, be referred to further, as it is the ultimate cure that is the concern of this discussion.

Now, as to the means of effecting this cure, it might be that where a structure consisted all of concrete, where the spans were short and where the proper provision for expansion had been made, that the porosity of the concrete could be corrected by the addition of some integral compound, and the structure so made water-proof. Unfortunately, however, in practical work such ideal conditions do not usually present themselves. While the floor is now universally of concrete, the supporting structure is usually of steel and as in problems of other sorts, so in this one, troubles rarely offer themselves singly. That is, conditions that present the most exacting requirements as to water-proofness, seem with remarkable regularity to call for the shallowest of floors and the longest of spans and there follows inevitably the breakage of the floor as previously explained. It is quite obvious that the addition of an integral compound cannot compensate for physical breakage and some other method must be sought.

The first method that might suggest itself would be the covering of the floor with a material that would be less brittle than concrete, and the original efforts were made along this line.

Figure 3 shows one of the first attempts at the construction of a water-tight bridge floor in which this method was used. It was a half-through plate girder bridge with transverse triangular trough floor system. The troughs were lined with an asphalt mastic, haunched at the girders and graded from the center to each side, where the trough was tapped to let the water out into a channel drain running the longitudinal length of the structure. The ballast was thrown upon the mastic and the ties set in the ballast. If the asphalt mastic were hard enough to bear the ballast, it could scarcely fail to break, not only over the main supports from the deflection of the span but also over each peak of the trough. Furthermore, as the mastic has no adhesive quality it would inevitably pull away from the main girders where it is run up against them and let water into the floor connections.

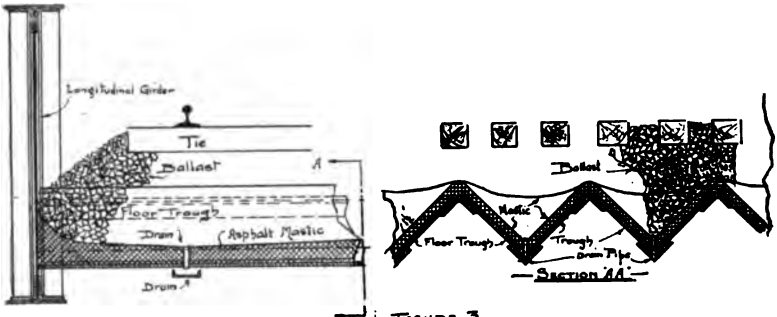


FIGURE 3

For the sake of brevity, in illustrating the development

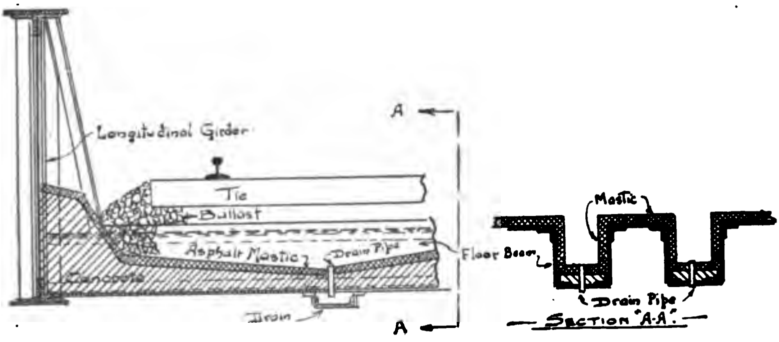
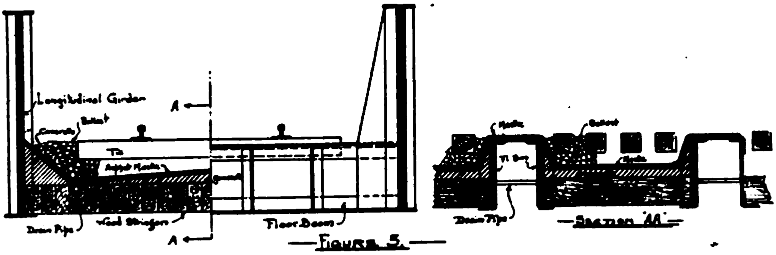


FIGURE 4

of the subject in what follows, but one type of structure has been referred to, the half-through plate girder railroad bridge, but in this one may be found practically all the difficulties that could be encountered elsewhere.

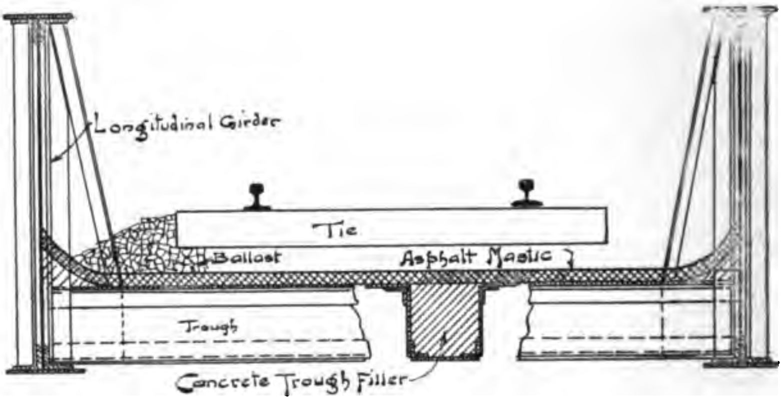
Figure 4 shows a scheme somewhat similar to that of Figure 3, but shows several elements of improvement. The troughs are square; a concrete filler is used in the troughs as a base for the mastic, and the haunching on the sides is carried up above the ballast line, but there still remains the individual trough drain and the longitudinal gutter. It is evident that the mastic would break at the trough joints and that the concrete filler and mastic would pull away from the girders when the floor deflected or the concrete shrank in drying.



—Figure 5.—

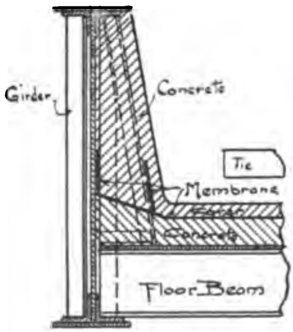
A very awkward construction is illustrated by Figure 5, but it presents one forward step in the progression. The individual trough drainage is eliminated and an attempt made to drain the floor on its surface. The floor beams are box girders supporting a solid floor system of wooden stringers covered with concrete as a base for the asphalt mastic, which is also flashed up over the floor beams. The troubles to be anticipated would be the breaking of the mastic over the floor beams, the opening between the haunching and the face of the girder and the stoppage of the drain pipes where they pass through the box girders, due to freezing, which would cause the water to dam up in the separate bays.

There is shown in Figure 6 still further progression. Here we have a square trough filled with concrete, so that the floor surface presents a common plane flush with the top of the plate of the up trough. This is a decided advancement in that it eliminates corners and their inherent cause of breakage and gives an even surface for the flow of the water. We still have, though, the asphalt cover and while some of the minor causes of rupture have been eliminated, there still remain those major ones,—breakage of the floor over main supports and separation at the girder lines.

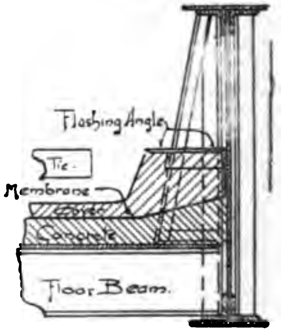


—FIGURE 6—

It has been through such laborious steps and annoying failures that progress has been made to the present-day idea on the subject, which is the incorporation in the mass of the concrete of an elastic membrane of water-proofing material that will stretch and not break as the floor does and that can be sealed permanently and elastically to the face of any

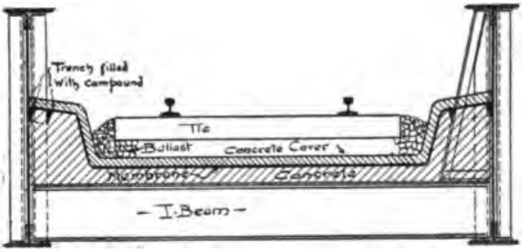


— FIGURE 7 —

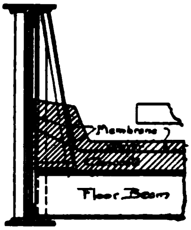


—FIGURE 8—

vertical surfaces against which it may abut, and much ingenuity and effort have been expended in recent years in attempts to realize this idea. It has, however, proved so difficult of accomplishment that many efforts have also been made to get away from the necessity of accomplishing it, such as breaking the floor slabs over the supports and inserting some sort of flexible joint or even a drain; putting a flashing angle on the supporting girders at the juncture of the floor and girder to protect the joint there; carrying the floor concrete up to the underside of the top flange of the girders, etc. Figures 7 and 8 show the two latter methods. All of these devices complicate the construction, add to its cost and are not necessary if it is possible to attain a truly elastic membrane capable of truly elastic attachment to the face of a vertical support of the floor in which the membrane is incorporated, and the possible practical attainment of such a membrane is the end in view in this discussion.



—Figure 9—



—Figure 10—

Figure 9 shows what may be regarded as an up to date construction of a half-through plate girder railroad bridge. The floor slab is supported by transverse I-beam floor beams and its top face presents an even graded surface throughout. The membrane is applied to this surface and is protected from the ballast by a cover of concrete, brick, or mastic.

The first membrane used was composed of alternate layers of coal tar pitch and treated paper. The pitch was swabbed on the surface of the concrete and then alternate layers of paper and pitch laid down, as many as six and seven layers often being used. The membrane was carefully flashed up the sides of the girders and around all stiffeners and brackets and glued to the surface with hot pitch, as shown in Figure 10.

This proved to be a considerable step forward and while the general results were much better, leakage continued to appear along the girders and over the supports.

The next step was the substitution of asphalt plying compounds for the coal tar pitch and asphalt treated wool felts for the tar treated papers. A different sort of connection to the vertical girders was also tried with both kinds of materials. Instead of flashing the layers of papers or felt up the sides of the girders, they were run into a V-shaped pocket at the juncture of the floor and girder and this pocket filled with tar or asphalt as the case might be.

These changes somewhat improved matters, but failed still, in very many cases to eliminate the leakage at the girder lines and over the supports. It was then thought that the tensile strength of the papers and felts might be improved by making one of the plies of woven fabric and this is the usual practice today where papers and felts are used.

It has also been thought that if the membrane were merely laid on the surface and not plied to it, the extension and contraction of the surface would be spread over the entire length and breadth of the membrane, instead of being localized at the line of fracture of the floor, as would be the case where the membrane was sealed to it. The objection urged to this, and it seems a very rational one, is that in the former case, if the membrane is punctured the water will enter the puncture and spread indiscriminately over the surface between the membrane and floor.

Another method has been to use woven fabrics plied with asphalt without any felt or paper. Burlap seemed to be an ideal substance for such purpose, at first sight, on account of its cheapness and open mesh, but it was found that if the compound broke, the water entered the burlap and on account of its hydroscopic property spread through it. It has also been attempted to saturate the burlap with the asphalt or pitch to correct this fault and to obtain better adhesion with the plying compound but it has been found in many cases where the burlap has been taken out after a few years service, that it had disintegrated, so the use of this material has been pretty well tabooed among engineers.

Cotton fabrics, supposedly saturated with asphalt, were then substituted for the burlap and appear to have given better results. The leaks have, however, despite all of these efforts continued to appear in the same old places, with sufficient frequency to give occasion for the remark quoted above from an authoritative source, that a really water-tight bridge floor was not possible.

This, I confess, was about my state of mind in regard to the subject when, in 1910, I was confronted with the problem of water-proofing the sixty structures involved in the construction of the New York, Westchester and Boston Railway. There were a number of particularly trying situations. Many of the stations had bridges just above their entrances; there was seven hundred feet of two-track viaduct to be carried over the Mount Vernon water supply, right of way had been given on the condition that there should be no drainage or drippings from the roadbed on the property; there was twenty-five hundred feet of viaduct including a transfer station at 180th; there were several places where the underside of the bridge floor formed the ceiling of the station concourse, etc.

Now, as has been shown before, an analysis of the causes of leakage appeared to indicate four main reasons:

(1). Porosity of the concrete.
(2). Breakage from temperature variation.
(3). Breakage over supports.
(4). Breakage at juncture of floor and supporting girder in through girder work.

And that, theoretically at least, the troubles arising from these defects might be remedied by the incorporation in the body of the floor of any elastic water-proof membrane capable of elastic attachment to any vertical surface against which it might abut.

The question then became, as leakage troubles seem to continue quite generally, was the theory defective or was the trouble to be attributed to composition of the membranes as used. There seemed no tangible reason for doubting the soundness of the theory, but it did not seem equally clear that the composition of the membranes was such as to guarantee the fulfillment of the theory.

The next step then became an investigation of the composition of the membranes in general use with this idea in mind.

There were two general types, as previously shown, both of which were dual in nature—that is, one type was composed of a woven fabric of some sort and a plying compound, while the other was composed of a treated paper or felt and a plying compound. It was evident that the fabrics were elastic, even if not waterproof, while the felts were so to some extent. But what of the compounds? Were they really elastic?

A number of these compounds were obtained, both pitches and asphalts, and tests made for elasticity. The results were quite uniform. They remained very nicely elastic at temperatures above 30 degrees Fahr., but below that suddenly hardened up and became not only inelastic, but quite brittle. The obvious conclusion from this finding was that the so-called elastic membranes consisted, at *temperatures below freezing* of one elastic element, the felt or fabric, and one that was totally inelastic. Indeed, it might be seriously questioned whether even the felts or fabrics saturated with the same compounds did not loose to a large degree their elasticity at low temperatures.

Now, unfortunately, in a climate such as that of New York a structure is subjected to deflection and impact at zero degrees as well as at, say, 95 degrees, while the contractive effect of the low temperature is liable to be more destructive than the expansive of the higher temperature, and if these physical effects necessitate a membrane that is elastic at any temperature they must necessitate a membrane that is elastic at all temperatures, low as well as high.

Now consider the action at low temperature—first, over the supports. The layers of fabric or felt are plied and to each other, and usually to the floor, with a material which at such temperature is not one whit less brittle than the concrete. The concrete we have seen, tends to break from the deflection of the span, and how is it possible that the compound should fail to follow suit? This having once occurred at low temperatures, the break is irreparable, as the melting point of all of these compounds is always higher than any temperature to which the structure will ever be subjected, and the break is thereafter protected only by the felt or fabric, as the case may be. Indeed, it seems extremely probable that the exterior skin of the felt saturated with the compound would also become britttle at the low temperature, break also, and leave only the untreated interior parts of the sheets intact. This portion of the sheets is certainly not waterproof, while in the case where the fabric has been used a few strands of burlap or cotton duck will not stop the passage of water. This analysis seemed to give a rational explanation of the continuance of leaks at the supports.

Next consider the attachment of the membrane to the vertical supporting girders. It has been shown that two methods of attachment have been used. First, the membrane is flashed up against the side of the girder and around all stiffeners and brackets and glued to this surface with the hot, melted compound. Second, a trench is formed at the line of juncture of the two and filled in with the compound. Now let us examine what occurs. Neither coal-tar pitch nor asphalt is adhesive except at high temperature, and in order that they may adhere to the steel of the girder even when melted the steel has to be very carfully cleaned with gasoline, while in order that they may adhere to the concrete all loose dirt has to be carefully removed. Assume, however, that a good grip has been attained to both steel and concrete while the compound has its transiently adherent property due to the high temperature and that the structure is then subjected to low temperature.

The floor deflects as usual under load, and tension occurs along the line of membrane and girder, but the attaching medium, the compound, has now lost all of its elasticity and disruption of the attachment would seem the inevitable consequence.

As previously mentioned, the question of the adhesion of the membrane to the surface to which it is applied has caused some discussion. It seems eminently desirable to have it adhere to this surface to prevent the indiscriminate spreading of any water that might be admitted through a local puncture or break in the membrane, and yet if it is so secured the liability to disruption is greatly increased, due to the localization of the strain along the line of any breakage in the floor surface.

The same reasoning applies to a certain extent to the protection cover of the membrane. Of course, there can be no adhesion between the cover and membrane when the latter is plied with a compound that "sets up" and has no adherent quality at ordinary temperature, and yet it would seem not undesirable to have such adhesion, because without it water may enter cracks in the cover, get between the membrance and cover, freeze, and heave the latter.

The final conclusion arrived at from this course of reasoning was that whatever the make up of these dually composed membranes, whether felt and compound or fabric and compound, it was the compound that had to be relied on eventually to effect the result, and unless it were possible to obtain a compound that was elastic at all temperatures, low as well as high, it was not possible to obtain a truly elastic membrane.

It followed naturally; too, from this that if such a compound were obtainable then the felts or fabrics that might be used with it would have a very minor role to play and that all of the elaborate and costly treatment and saturation would be superfluous.

Another important feature of such an ideal compound would be that it must not only retain its elastic property at low temperature, but that it must remain ADHERENT at low temperaure. This seemed desirable for several reasons.

The attachment of the membrane to the girders at their line of juncture seems most simply and easily made by means of the trench, or pocket, thus doing away with the painstaking and expensive flashing and fitting; but, as shown above, when this trench is filled with the ordinary tar or asphalt compounds great care has to be taken to get any adhesion at all, even when the compound is melted, and if this transient grip is once broken the damage is irreparable. On the other hand, if this trench would be filled with a material that not only remained elastic at low temperature, but also remained adherent at low temperatures, then even if the grip were at any time physically disrupted adhesion would again occur upon relaxation of the disrupting force. This would apply equally well, of course, to expansion joints or fissures or pockets of any sort.

Another attractive feature of such an ***inherently adherent*** quality in the compound would be that the membrane composed with it would adhere not only to the surface water-proofed, but also to the cover, and localize the breaks and cracks in both, while the non-hardening elastic property would prevent its breakage with either.

A third feature of this adherent quality that would be most useful would have to do with any reinforcing fabric that might be used with it. One reason for the treatment of these fabrics has been to insure a bond with plying compound. If, however, the compound could be made normally sticky or adherent, it could not avoid adhering to the fabric and bonding with it, and thus doing away with this reason for any treatment at all.

My ideal compound was, then, to be one that would remain NON-HARDENING, ELASTIC, COHERENT and ADHERENT at low temperatures as well as high. It was much easier, however, to evolve this theory than to fulfill it, and here at the end of the rope of the engineer the chemist had to be called to the rescue.

I was unable to find any compound on the market at that time that even approximately fulfilled these conditions, though I believe there are several now that claim to do so, and had to resort to special manufacture.

The surface to be water-proofed was then swabbed with this compound, upon which was laid one layer of *untreated* open mesh burlap, which in turn received a coating of the compound, and the membrane so formed was covered with three inches of concrete reinforced with poultry netting.

Two other features of this membrane were contrary to general practice, and these were the use of a one-ply membrane and the use of *untreated* burlap. With a membrane where the compound was the prime factor there seemed no especial advantage to be gained by multiplying the layers, while considerable expense was avoided by not doing so. The use of untreated burlap also made for economy and was admissible with this compound as it did not destructively affect the burlap as do tar and asphalt.

After four years' service this work has proven to be so far entirely satisfactory, and this fact is my excuse for presenting this discussion.

Some time ago a section of the membrane was taken out and it was found that the compound had retained its elasticity, that the burlap was in perfect state of preservation and that the membrane had adhered strongly to both base and cover.

To recapitulate, then: The theory evolved and which it was attempted to prove was that if a structure subject to moving load and temperature variation is to be water-proofed it can only be effected through the medium of a membrane incorporated in the floor which fulfills these two conditions.

(1) The compound element of this membrane must of necessity be the eventual factor upon which reliance is to be placed

(2) The compound, to fulfill its true function, must remain water-proofed, non-hardening, elastic, coherent and adherent at low temperatures as well as high.

DISCUSSION

J. F. French, Mem. B. E. C.: This paper is an interesting contribution to the general subject of waterproofing railroad bridges, and should have a good effect in calling attention to the difficulties to be met and the necessity of giving careful consideration to waterproofing details throughout the design and construction of such work. Waterproofing of the character described is expensive and unless thoroughly well done is worse than useless, as poor waterproofing gives a false impression of security and may cover up defects which are, on that account, liable to become serious before detection.

Any waterproofing material which will meet the author's stated requirements by remaining "waterproof, non-hardening, elastic, coherent and adherent at low temperatures as well as high" is well worth knowing about, and the paper will be made more valuable if the composition or trade name of the material is explicitly stated. It should be emphasized, however, that the most excellent waterproofing material possible may be rendered practically useless by careless application and faulty structural design. Structures subject to such heavy live loads as railroad bridges carry must necessarily deform to some extent under load, and the more accurately this deformation is anticipated and taken into account in the design of the details of the waterproofing the more nearly will the structure prove waterproof. Unless the continuous elasticity of the waterproofing material can be relied upon to stand the distortion at any point without breaking under all conditions of load, temperature and exposure the waterproofing membrane or film should be cut at such points and a proper joint provided. In the half-through plate girder bridges referred to in the paper the most difficult thing to accomplish is a really effective joint between the waterproofing membrane or film and the web plates of the girders, and even with material meeting the ideal requirements laid down by the author the writer would use bent plate steel flashing and would arrange, if possible, to have these joints carefully inspected and sealed up with new compound once or twice a year.

A considerable number of half-through railroad bridges, similar to those described by the author, built and waterproofed about nine years ago, have been under the writer's observation throughout that time and are as nearly watertight to-day as any similar structures of which he has knowledge. The only repairs which have been made to the waterproofing of these structures have been in the joints between the membrance and the girder web plates under the flash angles, and the repairs made have proved effective. The waterproofing materials used on the structures referred to included both tar paper and felt as fabric, and both coal tar and asphaltic mixtures as waterproofing compound. The details of these structures were quite fully described by the writer in a paper which he read before the Club in April, 1908, on the Bridge Superstructures of the Bay Ridge Improvement of the Long Island Railroad.

Mr. MAXIMILIAN TOCH (by letter): Mr. Rhett's most interesting paper on "The Waterproofing of Structures Subject to Stress from Moving Loads and Temperature Variations" is unique. It is a very strange thing that we have known for years the defects which arise in the waterproofing of a structure subject to the conditions just named, but it is only after disagreeable facts are forced home to us by bitter experience that we are willing to change conditions. We have an analogous case in the manufacture of chemicals in the United States since the great European war. We have known for many years the necessity of manufacturing chemicals, but we have been apathetic until this great war has driven home to us the serious fact that unless we manufacture nitrates from our own resources we shall some fine day be cut off from the rest of the world and unable to defend ourselves, and so it is with practically everything, including the waterproofing of structures, which have a bad habit of leaking under conditions which ruin them and make a general mess of the roadway underneath, and the credit should go to Mr. Rhett. for having fathered the thought of solving this problem.

Up to the time of this investigation every waterproofing material was tested for its melting point and its resistance to water under what I call "test-tube" conditions. It reminds me very much of the study of antiseptics in medicine. Bacteria have been taken and cultivated in the laboratory and then it was found that the most virulent poison was bichloride of mercury, but somehow or other this did not work out satisfactorily when applied to the human being, and when a common sense bacteriologist came along and announced that soap and water was the best germicide for the simple reason that it was unctuous enough to remove them from the surface of the skin, bichloride of mercury became a back number. And so it was with waterproofing materials which were taken in the laboratory and tested and subjected to water for a week, and if they showed no change that ended it. But by degrees the chemist and the engineer got together, and the chemist showed the engineer that if burlap was used in the presence of a waterproofing material containing sulphur, sulphur acids were generated which rotted the burlap and thereby destroyed the waterproofing material itself. Then again, the question is not how flexible or elastic was a waterproofing material under heat, but how elastic or flexible was it under extreme cold, and if it broke would it go together and heal itself, and while a little of the credit may belong to the chemist, the greater credit goes to the engineer, for we have at least found the cause, and in finding the cause we have aided the results. The problem has been almost solved, and at least it is solved sufficiently to warrant waterproofing under the conditions named.

I am very grateful for the opportunity that has been given to me in adding a word of tribute to the skill of Mr. Rhett, who justly deserves the success that he has had.

BROOKLYN ENGINEERS' CLUB

No. 140

CONSTRUCTION OF FOUNDATIONS FOR LARGE TURBO GENERATORS AND OTHER APPARATUS UNDER DIFFICULT SUB-SOIL CONDITIONS

By G. Laurence Knight, Mem. B. E. C.
Presented October 12, 1916.

The principal power station of the Edison Electric Illuminating Company of Brooklyn, shown in Fig. 1, is situated at the foot of Gold Street on the East River and will be capable during the coming winter of supplying electrical energy to the extent of 100,000 Kw., or approximately 135,000 H. P.

The station building was originally constructed for engine-driven generators, but extensive alterations were made in 1905, when the first of the turbo generators was installed, to provide condensing tunnels, crane capacity, electrical galleries, etc., for very largely increased capacity, due to the space saving and

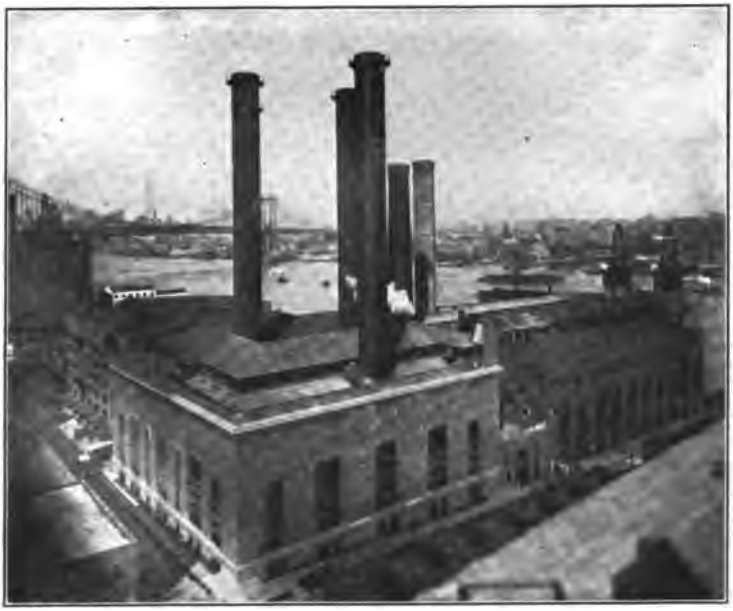


Fig. 140-1.—General View of Gold Street Station.

increase in economy made possible by the introduction of turbines as prime movers.

This paper will describe the installation of the two latest and largest of these turbo generators, Nos. 3 and 4, with particular reference to the foundations, which were constructed under unusual and difficult requirements both as to superstructure and sub-surface conditions. Another and somewhat similar foundation job is described at the same station involving the placing of steel piles and replacing the steel columns under an existing building due to the necessity of adding two additional stories to the building, each with excessive floor loading.

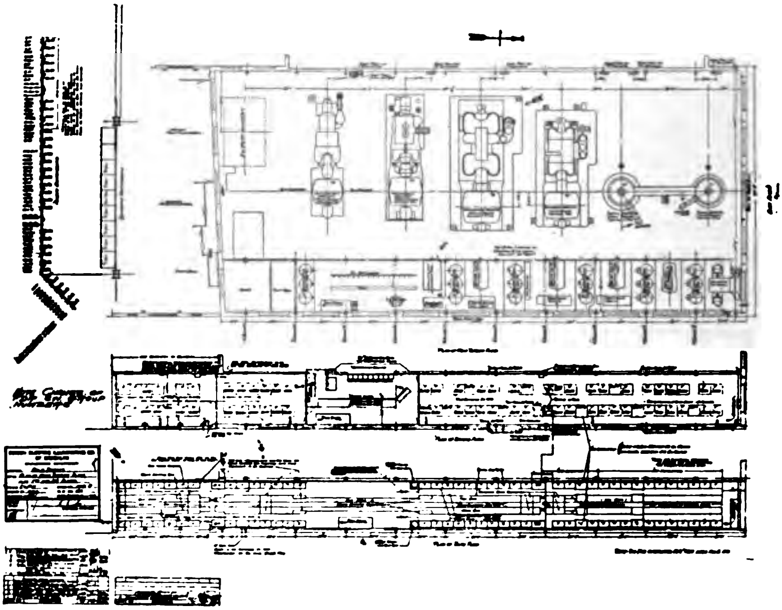


Fig. 140-2.—Position of Turbines in Operating Room.

Fig. 2 shows the relative position of the machines in the Operating Room, with the generating capacity of each. These figures and the relative location of the machines should be particularly noted, as constant reference will be made to them throughout the paper.

No. 3 Turbo Generator.

To make clear the reasons for the design of No. 3 foundation, the first to be considered, it is necessary to review briefly the steps which led up to it.

In 1911, when the last vertical turbine, a 12,000 Kw. unit, was installed, it was intended to make No. 3 a duplicate of No. 2 and install it during the following year or not later than 1913. In view of this plan, the foundations for No. 3, below the basement floor level, together with the connections to the condensing tunnel, were put in at the same time as those of No. 2. Conditions of load, however, made it unnecessary to purchase additional capacity until 1914. In the meantime steam turbine design had undergone rapid changes, due principally to the increase in rotative speeds, which resulted in greater economy in steam consumption per kilowatt hour and decreased cost per kilowatt of the entire unit.

It thus became possible to purchase a 25,000 Kw. turbo generator at 1,500 R. P. M., the steam consumption of which was 12½ lbs. per Kw. hour, in place of the 12,000 Kw. vertical unit previously planned, which, like No. 2, would have had a steam consumption of 15½ lbs. per Kw. hour at 750 R. P. M., and install it in the same space as the 12,000 Kw. vertical unit. In short, the capacity of the unit was more than doubled, the efficiency increased 20% and the cost per kilowatt decreased by about 30%.

The principal dimensions of No. 3 turbo generator are as follows:

Length Overall	45 feet
Width Overall	19 feet, 2 inches
Weight of Turbine	241,000 lbs.
Weight of Generator	342,000 lbs.
Total Weight	583,000 lbs.

The turbine required a condenser having 35,000 sq. ft. of surface; the condenser shell and tubes weighed, empty, 300,000 lbs. and when completely filled with water, 618,000 lbs.

The conditions in the station with regard to condensing tunnels, minimum length of nozzle connecting turbine to condenser, together with the necessary requirements of accessibility and handling, led to the installation of the condenser immediately under the steam turbine, with its long dimension parallel to the center line of the turbine shaft.

In the reaction type of turbine, to which No. 3 and No. 4 belong, the end clearances of the blading are very close and it is extremely necessary in designing a foundation for such a unit to make deflection negligible and to reduce the vibration to a minimum. Mass concrete for such foundations would obviously have met the requirements best, but on account of the position of the condenser, the height available from basement floor to main floor of the turbine room and the clearances necessary it was found absolutely impossible to provide space for a concrete foundation. It was, therefore, decided to erect a steel platform supported on columns and heavy grillages with a very liberal allowance for factor of safety.

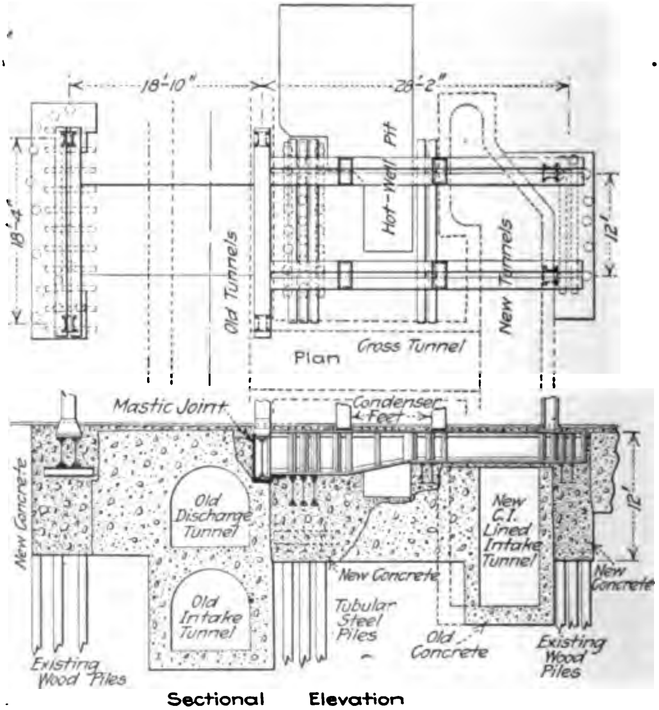


Fig. 140-3.—General Arrangement of Foundation Design and Clearances.

Fig. 3 shows the position of the condensing tunnels, both intake and discharge, and it will be noted that the intake tunnels, of which there are two, both pass through the area occupied by No. 3 foundation. The westerly tunnel carries intake water only whereas the easterly structure has both inlet and discharge tunnels, and extends some 24 feet below the surface of the basement floor, hereafter referred to as datum. The double tunnel structure was not considered strong enough to carry the load of the turbine foundation and machine and it was, therefore, necessary to build the foundation entirely independent of the tunnel structure.

The westerly tunnel, built in 1912, is of reinforced concrete construction lined with cast iron plates. It is on good bottom, so that there was no danger in using its walls within the limits of their design for some additional weight.

The problem before the designer was, therefore, to evolve a steel superstructure with girders having a maximum allowance or deflection of .02 inch, the reduction of vibration to a minimum, a rigid restriction on placement of every member due to narrow clearances and the whole on a foundation so safe as absolutely to prevent the least settlement under severe operating conditions throughout the life of the machine. Designing the girders for the deflection allowed resulted in reducing the unit stresses to 4,000 lbs. per sq. inch or a factor of safety of 16 instead of the usual 4.

Referring to the cross section, shown in Fig. 3, it will be seen that the structural design adopted consists of a pair of cantilever girders resting on a fulcrum of three girders supported by sectional tubular steel piles filled with concrete. The cantilever girders carry in turn the middle columns of the turbine foundation at one end just beyond the fulcrum, and at the other end the two columns under the steam end of the turbine. The same girders support the condenser. The columns supporting the outboard end of the generator are entirely independent of the rest of the foundation, because of the impossibility of carrying the foundation over the discharge tunnel structure. In this case it was not necessary to put in additional substructure, as there were good wooden piles in place; furthermore, the soil proved sufficiently good to carry safely the load for 1¾ tons per square foot, even had the piles not existed.

In constructing the foundation the first work to be done was to clear away and cut out all the mass concrete previously installed for No. 3 foundation.

The method consisted of drilling rows of holes six inches apart to the depth desired, using air and steam drills, and then breaking off in shelves with plug and feathers. The concrete, while hard and homogeneous, was very difficult to excavate. Instead of coming away in blocks, it shaled off in three- or four-inch layers, and in no case were the pieces as large as one-man stone. This fact rendered the progress of the work very slow, and the cost of excavation ran up to an almost prohibitive figure.

When excavation had been carried on sufficiently to permit pile driving, a machine was brought into the building and set up over the work and driving began.

The reason for the selection of the tubular piles was that wooden piles were impossible to drive due to the existence of old crib work, probably part of an old dock at this location, which made it impracticable to use mass concrete. As excavation had previously been carried to this depth and no certainty obtained of encountering good bottom except below this point, and as this area was too great for open caisson work, the choice lay, therefore, between work under air and tubular steel piles. Furthermore, on account of the proximity of No. 2 foundation, which was not piled, but whose bottom rested directly on the soil 12 ft. below the basement floor, it was not deemed advisable

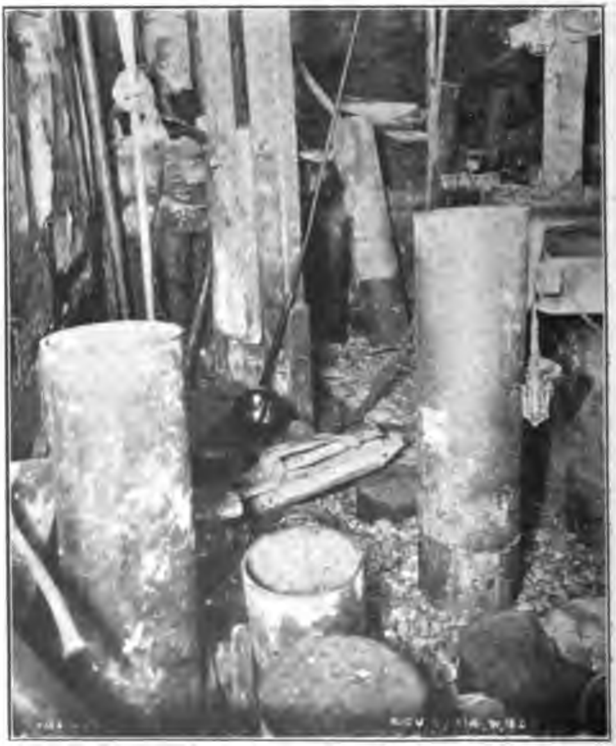


Fig. 140-4.—Sectional Steel Casings During Driving.

or safe to jet the piles. The method adopted was to drive the steel shells as far as possible and then excavate with a 10-inch Hayward orange peel bucket inside the pile. Figs. 4 and 5 show some of the steel casings during driving and the Hayward Bucket.

The piles selected were 12″ in diameter with ⅜″ shell driven in sections of convenient length, the joint being made by means of a sleeve 12 inches long and of the same outside diameter as the inside of the pipe. The sleeves were held in place by center-punching the pile sections 6 inches on each side of the joint. The material was excavated from inside as the pile was driven. The first sections used were 18 ft.

The piles drove anywhere from 5 to 10 ft. in the first driving. The instructions given the inspectors were to drive until the pile came to refusal of ¼ in. in three five-foot drops of the hammer or until they heard the ring of a boulder or got the spring of timber.

At the end of the first driving the clearing crew started in, using an auger, a chisel bar and the bucket. The auger proved of little use as there were too many small stones and other obstructions to permit its turning, although it was used whenever the chisel bar showed that there was a section of sand or soil fairly free from stone. The procedure throughout the work after each driving was to use the chisel bar to loosen up the material inside the pile and then with the bucket remove the material to within a foot of the bottom of the pile.

The old crib dock or wharf whose bottom rested some 30 feet below datum, of course accounted for the many obstructions encountered. These were principally boulders, rough stone and the timber itself, many pieces of which lay horizontally in the path of the piles and were cut through and a section brought up by the bucket. Fig. 6 shows a few typical prizes recovered.

As is usually the case with such jobs, the progress was very slow and unsatisfactory at the start of the work, but as soon as the crew got used to their duties the work went on with remarkable speed considering the difficulties encountered. There were two driving crews (one day and one night) and three excavating crews (two day and one night). Three buckets were used, so as to be sure to have one spare at all times. The best speed accomplished was three feet in one hour and the worst two feet in 33 hours.

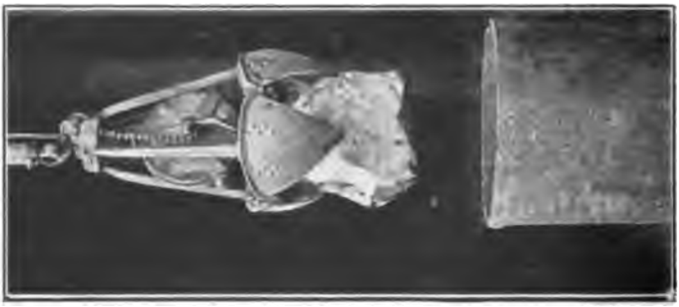


Fig. 140-5.—10" Hayward Orange Peel Bucket, Showing Relative Size of Steel Shell and Obstructions Removed.

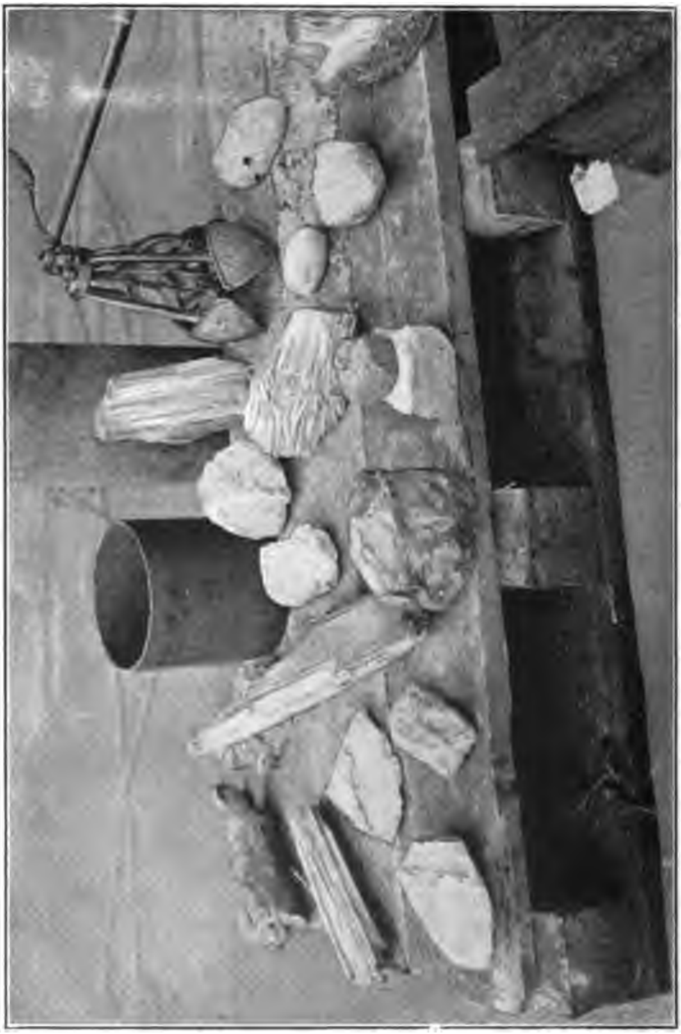


Fig. 140-6.—Various Samples of Material Removed from Piles (No. 3 Foundation).

At the north end of the excavation, a section of concrete was encountered where a sump used in the construction of No. 2 foundation had afterward been filled with concrete, and which lay directly in the path of the three piles at the north end. As the bottom of this concrete was some 17 feet below the surface, it was impracticable to excavate it in the open, and it was determined to drill three holes in the concrete to admit of the piles being placed in their proper positions. A well drill was secured and placed in the ways of the pile driver, and the three holes—15 in. in diameter and about 5 feet deep—were cut through in four days. The three piles were then inserted in the holes and driven to place.

The depth at first set for the bottom of the piles, after examination of the soil excavated, was 10 ft. below the bottom of the condensing tunnel, or 34 ft. below datum.

In some cases where the pile encountered a boulder, but glanced off, the bucket was blocked after one driving, although the driving indicated nothing unusual. Where the pile had been driven only a few feet, it was pulled up and replaced with a slight change in location, the work proceeding then very cautiously, using a smaller core drill inside the piles to break through the boulder in case it was hit again. Not only were the bottom of the piles damaged, but in some cases the second section was telescoped with the first. In another case the sleeve slipped and the upper or lower head section was driven eccentric to the bottom section for a distance of some 2 feet before it was discovered.

As the piles were laid out as close together as practicable it was not possible to drive other piles to make up for the loss of these. Each case had to receive careful consideration on its merits. Sometimes the pile was pulled, and where this was impossible it was filled up and the piles adjacent driven to a greater depth. In still other cases, where the break was near the surface, a sheeted pit was made around the pile, the material excavated in the open until the joint was uncovered, the damaged steel cut off and a new section put on. Fig. 7 shows one of the damaged shells.

In all 23 piles were driven in one month, working 24 hours a day. When about half of the piles had been driven to the refusal stated, or work had been stopped on them on account of obstruction, it was decided to concrete two piles typical of

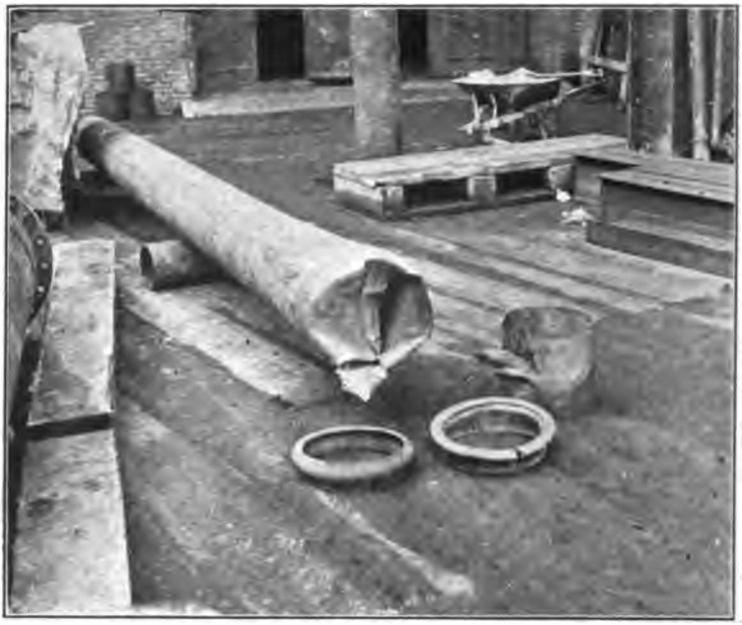


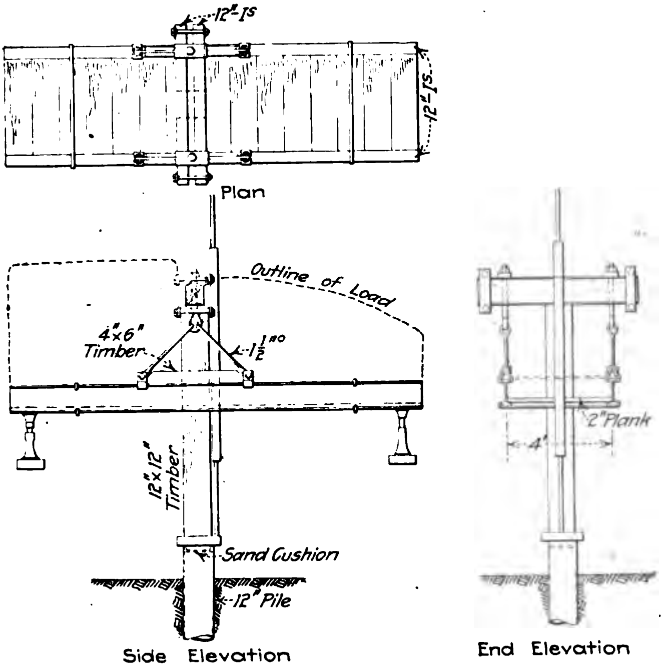
Fig. 140-7.—Deformation of Steel Shell Taken from No. 3 Foundation, Due to Striking Some Obstruction.

existing conditions and test them with actual load, so as to be able to judge the necessity of going deeper with the remaining piles.

The piles were expected to carry a load of 20 tons each, and it therefore was desired to load them with at least 30 tons and if no settlement occurred, to continue the loading up to 40 tons.

The test rig used is shown in Fig. 8, the rig itself weighing 1½ tons. It will be seen from the drawing that the platform of I beams on which the load rests is supported on jacks during the loading process. Provision was made to back off the jacks slightly at first for balancing, and afterward back away with one inch or more clearance of the blocking to allow for possible settlement, but preventing accident from any shifting of the load. The rig with load on is shown in Fig. 9.

Readings were taken with a level on an iron resting directly on the pile cap as shown in Fig. 10 and protected from the load pigs by an iron pipe through which it passed freely. To the level rod was secured a piece of white paper on which a fine pencil was drawn at the start of each loading, so that very accurate readings were possible.



Plan

Side Elevation

End Elevation

[illegible]

The tables shown in Fig. 11 give the results obtained on Piles 11 and 12. No. 11 pile had only one section, 18 feet long, the driving having been stopped on account of the bottom of the pile turning over against a boulder or other obstruction and preventing the bucket from going through. As this pile was at the outer edge of the footing and extreme difficulty had been experienced in driving it, it represented about the worst condition of any of the piles, and a 25-ton test was considered sufficient.

No. 12 pile, on which the other test was made, was a very satisfactory one. The pile had been driven successfully to a depth of 21 feet 7 inches below the excavation, or 34 feet 7 inches below datum, in two sections of 18 and 5 feet respectively and the excavated material showed that it was fully 3 feet into good sand bottom.

After the rig had been shifted, the second test was started at 30 tons. As there was no settlement at all the load was continued to 35 tons and then as settlement was inappreciable, being only 3-32 of an inch in 24 hours, the load was continued to 40

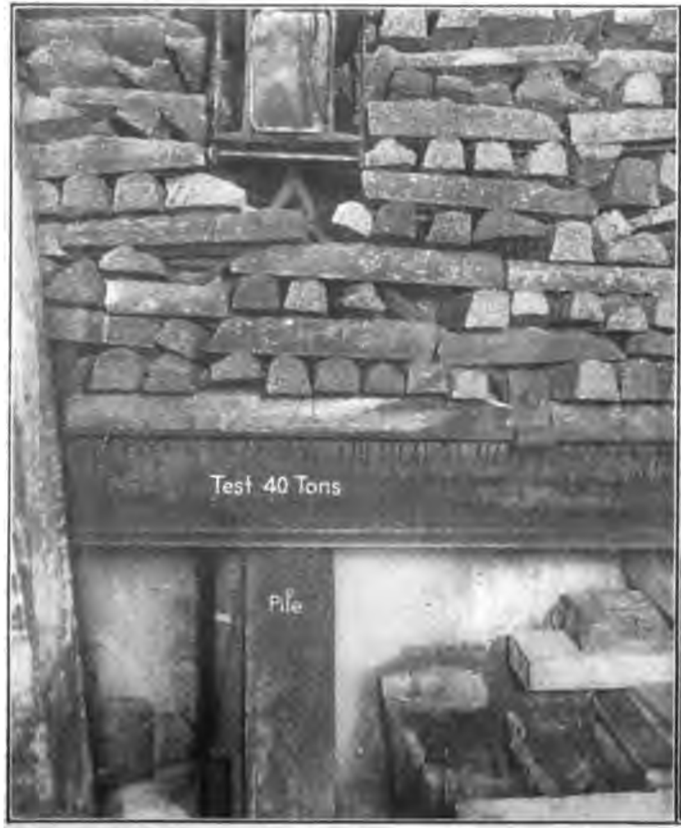


Fig. 140-9.—Load on Test Rig.

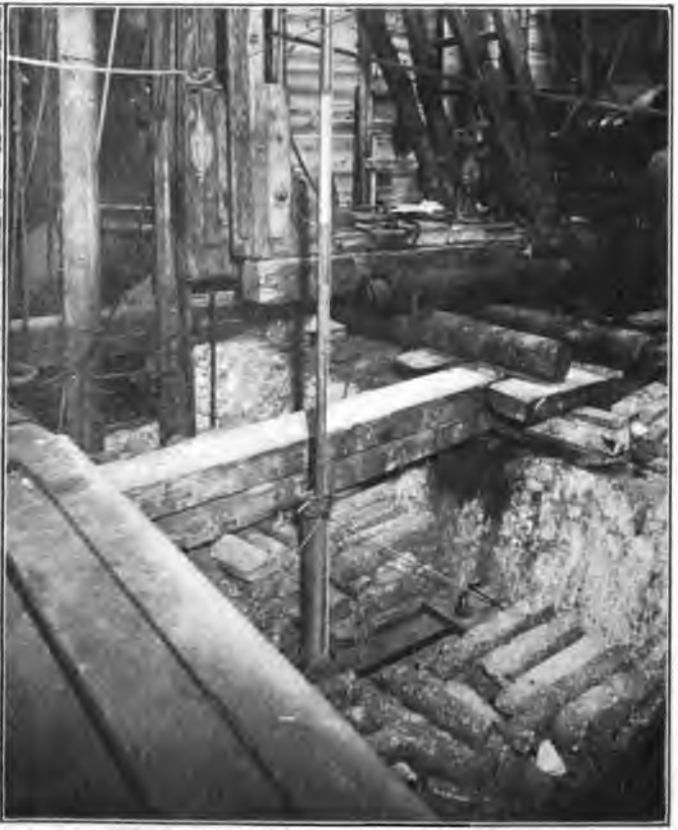


Fig. 140-10.—Level Rod.

LOADING TEST PILE NO. 11.

Date.	Load Tons.	Time Load on.	Time Load off.	Settlement.
10/25/14............	25	11:00 am		Down 11/64" on cap when first put on, due to compression.
10/26/14............	25		11:45 pm	Up 3/64"; not accounted for.

LOADING TEST PILE NO. 12.

Date.	Load Tons.	Time Load on.	Time Load off.	Settlement.	Remarks.
10/27/14	30	3:30 am	3:10 pm	3/16" due to compression of sand cushion under cap when load first put on.	No settlement thereafter.
10/27/14	35	4:00 pm	7:30 am	1/16" immediately. 1/32" next half hour.	Ditto.
10/28/14	40	8:38 am	4:25 pm	5/64" immediately.	Ditto.
10/28/14	40.5	4:49 pm	7:15 am	1/64" immediately.	Ditto.
10/29/14	45	8:00 am	8:00 pm	1/32" immediately. 1/32" next half hour. 1/32" between 12:30 and 1:30 pm.	No settlement thereafter to time of load off.
10/29/15				Up 1/32" when load off.	

Total ....9/32", except initial 3/16".

Fig. 140-11.—Table of Results of Test.

tons, resulting in the additional settlement of 5-64 of an inch. In the interest of experience and because the rig proved so very practical the load was run up to 42½ and 45 tons with the results shown in the table. The test on Pile No. 12 was so satisfactory that it was felt that ample factor of safety was provided, even making allowance for the piles driven to less than the full depth.

The loading material consisted of pigs of cast iron each weighing about 42 pounds. As they were borrowed for the purpose the tests were made at reasonable cost.

From this point the placing of the piles was completed expeditiously. As soon as placed they were dredged out with the orange peel buckets and filled with concrete. As the piles when driven contained water to depths varying with the conditions of the soil at the bottom of the pile, the concrete had to be placed with a tremie, precaution first being taken to place about a foot of broken stone in the bottom of the pile and to tamp it well. After filling, each pile was given about five blows of the driver to settle it in place. Concrete was then placed around the pile tops to a depth of about a foot above them, and a double grillage of I beams was placed to distribute the load over the piles. The foundation concrete was then brought up to within 2 inches of the bottom of the cantilever grillage girders, in readiness for the steelwork.

For the foundation for the end columns, on both the east and west ends, the concrete was placed on a bed of broken stone, which had been tamped solidly to a depth of one foot. In one operation the concrete was brought up to a level of 1 inch below the bottom of the grillage beams. The steel erection presented no unusual difficulties and progressed without special incident. The cantilever girders with columns in place are shown in Fig. 12.

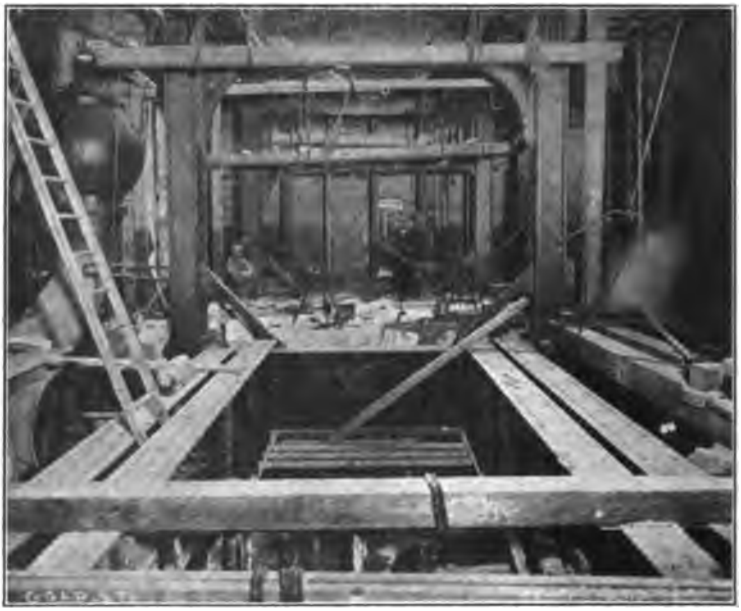


Fig. 140-12.—Cantilever Girders with Columns in Place.

SHOP AND WASH HOUSE.

Last year (1915) the facilities for distributing the increased generating capacity provided by the larger turbines had taxed the capacity of the electrical galleries at the Gold Street Station to the maximum and space was required for additional electrical switch and bus compartments as well as to provide quarters for plant efficiency laboratory work and for operating and construction offices. It was decided to meet these requirements by adding two additional stories to a building erected in 1911 to act as quarters for storeroom, machine shop and locker and toilet rooms for employees of the plant, and located adjacent to the south end of the operating room.

This building, shown in Fig. 13, was erected as a two-story

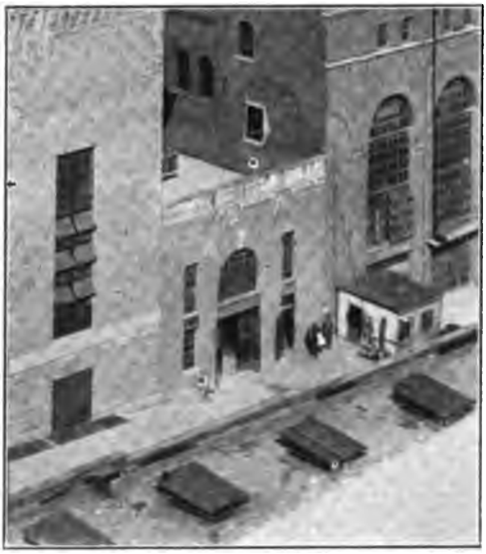


Fig. 140-13.—Shop and Wash House Before Alterations Began.

building approximately 40x100 feet, the foundations resting on fill, as the loads to be carried were light and necessitated only spread concrete footings. The two additional stories, however, proposed to be added to the front 50 feet of the building, had to be designed for carrying very heavy loads of 600 pounds per square foot, due to the masonry compartments on the two upper floors. These loads together with the heavy structural work and concrete and the necessity of maintaining a driveway from the street through part of the grade floor required careful location and minimum number of columns and made the loads unusually heavy on each one.

Reference to the plan Fig. 14 shows the location of the columns and loads on each, and the design of the foundations and grillages.

The fill under the old building was 20 to 30 feet deep due to the fact that an old slip had existed at this point. A study of conditions showed immediately that piles would be required and the choice lay between wood piles driven or jetted, steel piles driven with a point or steel piles driven open ended and excavated from the inside.

Previous experience in the foundations for the boiler house adjacent showed that serious difficulties were to be expected in driving as the fill was full of stones and boulders at the level of what was formerly the old beach. Borings led to the conclusion that a strata of boulders was likely to be encountered, large ones at the undisturbed beach line and smaller stones and crib work in the fill. Such conditions eliminated from consideration the wooden piles driven by either method. The sectional steel closed pile driven with a point, being much the cheaper of the two, was obviously the first choice, and in order to prevent these piles being stopped by the layer of boulders above referred to it was determined to drive the piles in sheeted pits excavated until stopped by water conditions, removing the boulders and stones as the excavation progressed. This method proved entirely feasible and satisfactory in the first pier and was carried on throughout.

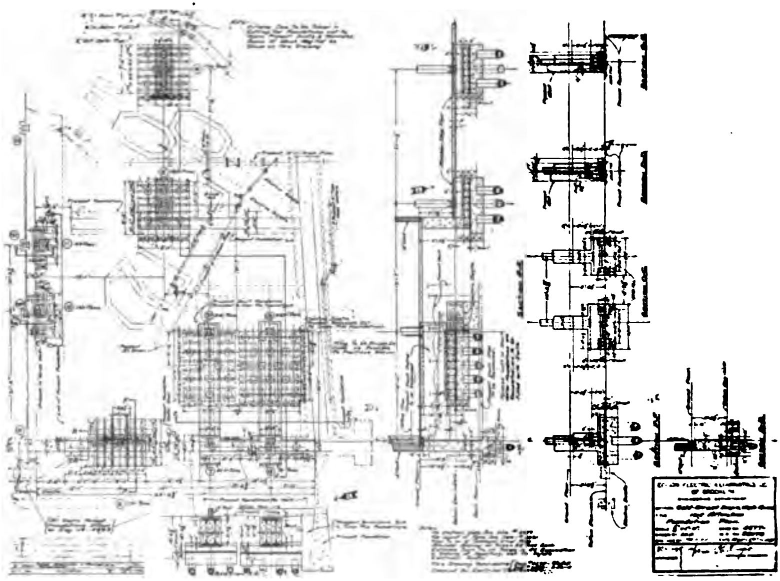


Fig. 140-14.—Grillage Plan, Showing Position of Columns and Loads on Each.

The new foundation work was complicated by the necessity of shoring and maintaining the existing building throughout the progress of the work, the front wall and roof being the only parts removed.

The contractor was required to build a temporary protecting wood roof and make it watertight before the roof concrete and structural steel could be removed and to build temporary partitions back of the front wall to afford like protection.

As the head room for pile driving was extremely limited the contractor constructed a special set of ways for his driver which could be used in the usual manner or the position of the ways changed both as to angle and height. The braces on the driver were hinged top and bottom and so adjustable that when the ways were in the hole the long upper member of the spliced braces could be removed and a shorter one interchanged as indicated on the sketch. This permitted driving without the use of a so-called "goat" and made it possible to get the pile driver ways in many awkward positions which otherwise would have rendered necessary the use of special ways and leads to the drum. The drawing Fig. 15 shows this arrangement and the adjustable bracing between ways and platform.

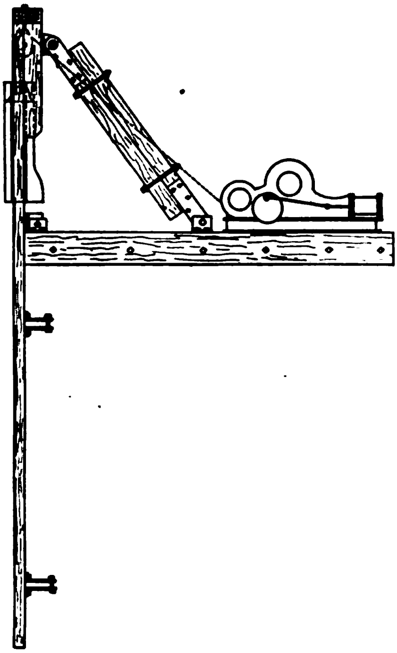


Fig. 140-15.—Diagram Showing Special Set of Ways.

The pits were carried down to an average depth of 12 feet in the Machine Shop and 16 feet from the higher level of the driveway. The piles used were 12-inch in diameter 3-8-inch sectional steel shell and for the first section a 20-foot length or

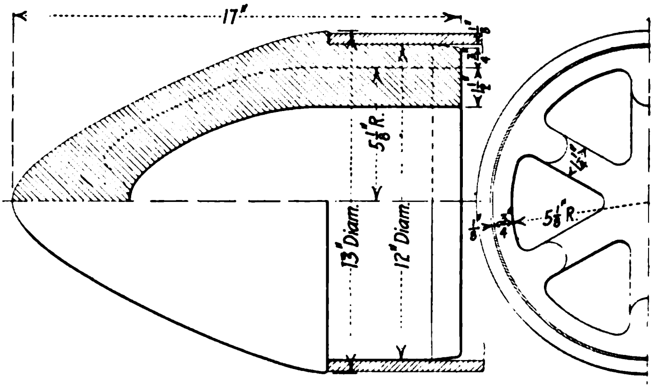


Fig. 140-16.—Pile Shoe.

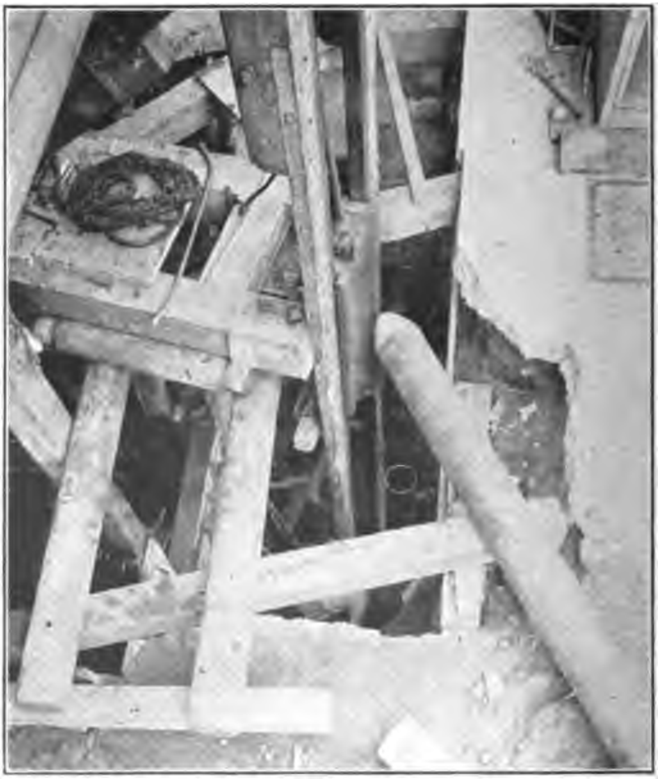


Fig. 140-17.—Pile Driving Rig Over Pit for Columns 7 and 7-A.

more was used with a cast steel point specially designed for and used for the first time on this job. The sleeves between the sections of these piles were of the cast steel inside type as shown in the cut. The cap used on the top of the pile to take the shock of driving and to prevent buckling was designed as shown in Fig. 16. After the first pile was driven this was supplemented by a heavy forged steel ring clamped on the outside of the pile immediately under the cap which proved very effective in preventing upsetting of the steel.

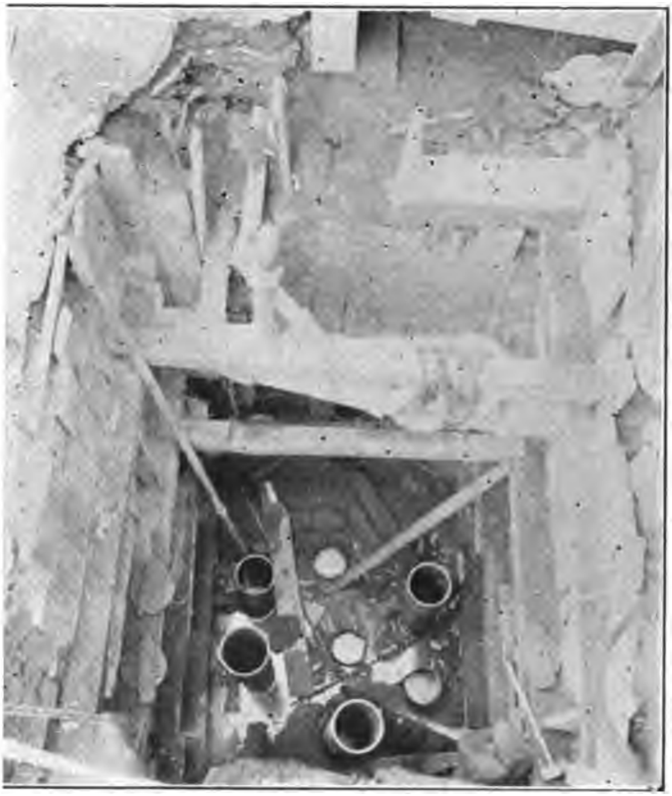


Fig. 140-18.—Looking Down Shaft No. 4.

The piles were driven to an average depth of 25 to 30 feet below the bottom of the pits. This meant that the piles were driven in the soil 12 to 15 feet below the bottom of the excavated pit and in some cases going as far as 30 feet in the soil. The maximum length of section was used according to the length which each pile was expected to bring up, the intention being to cut off the piles at the proper height for concreting under the foundation pier. Where driving left the length too high for this purpose, the piles were cut off with hack saws. Figs. 17, 18 and 19 show the pits and piles while the work was in progress.

In the large double piers at the front of the Gold Street wall a mattress of boulders was encountered, one boulder being about 10 cubic yards in volume and another one nearly as great. Fig. 20 shows the pit and the boulders encountered.

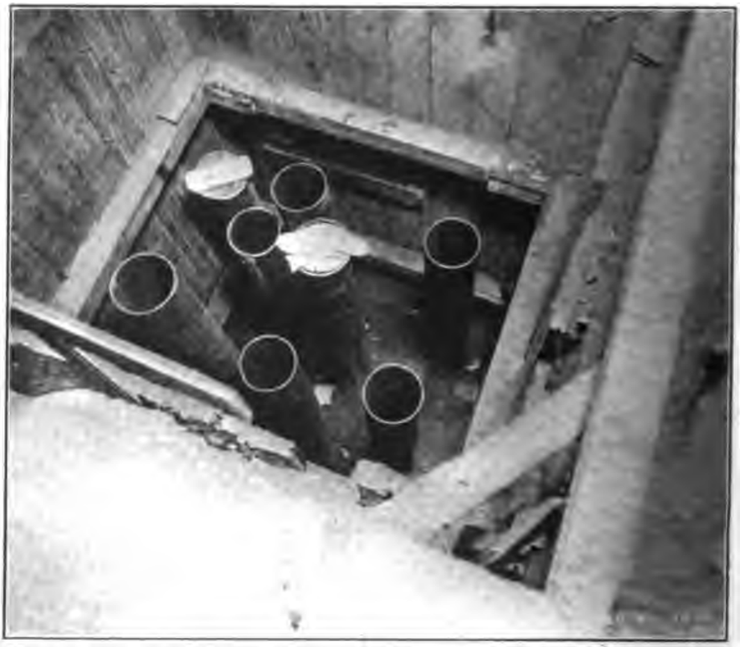


Fig. 140-19.—Another View of Shaft No. 4. Showing Steel Tubes Added from Bottom of Pit to Mid-tide Level.

It may seem that it would have been better engineering to put concrete in the hole from that point up, but the decision to remove the boulders proved entirely justified as after they were removed the piles were driven easily to a depth of 25 feet below the boulders and the soil just under the boulders was of such consistency that no confidence could be placed in its bearing capacity.

As the driving was finished on each pile an incandescent light was lowered to the bottom of the shell to make sure that the pile was in perfect condition before concreting. In a few cases the joint between the point and the first section had been opened slightly and water came in, but in most of the piles the light could be lowered to the bottom showing a perfectly dry clean shell.

When the piles were all driven in one pit and cut off at the proper height they were filled with concrete and the entire pit back filled to mean tide level, below which they would be permanently wet and, therefore, little subject to corrosion. The fill was left 6 inches below the top of the pile and the concrete pier foundation for the columns installed from this grade to grillages as shown in Fig. 21.

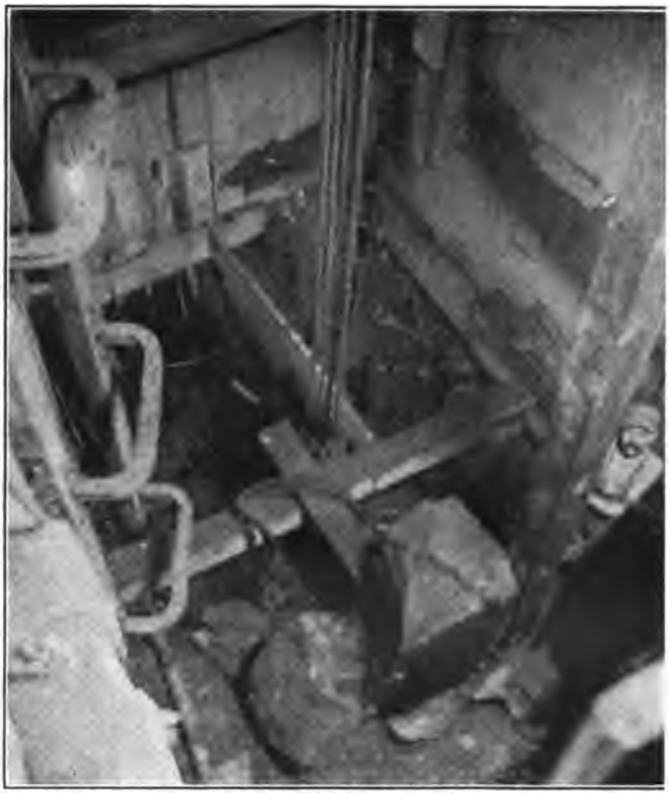


Fig. 140-20.—Pit Over Columns 7, 7-A, 12 and 13, Showing Boulder Encountered Which Had to Be Broken Up.

Fig. 22 shows the shop and Wash House Building after alterations were complete.

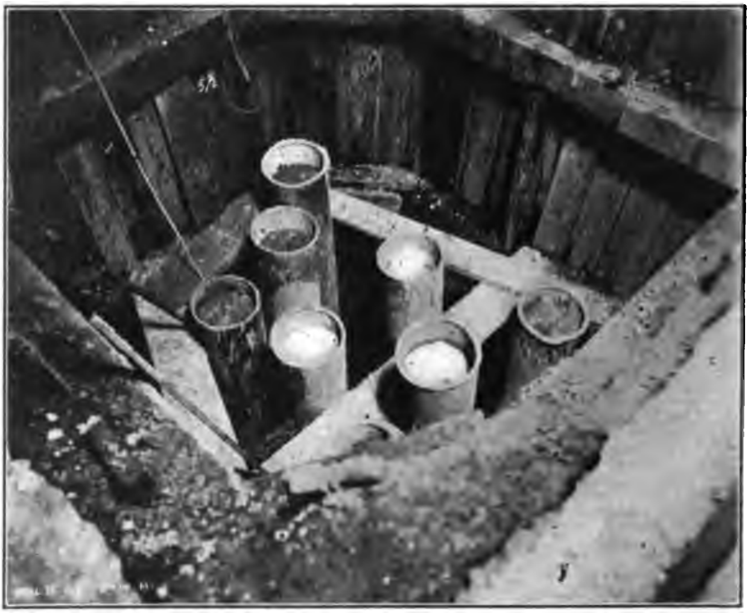


Fig. 140-21.—Another View, Showing Piles Concreted Ready for Back Fill.

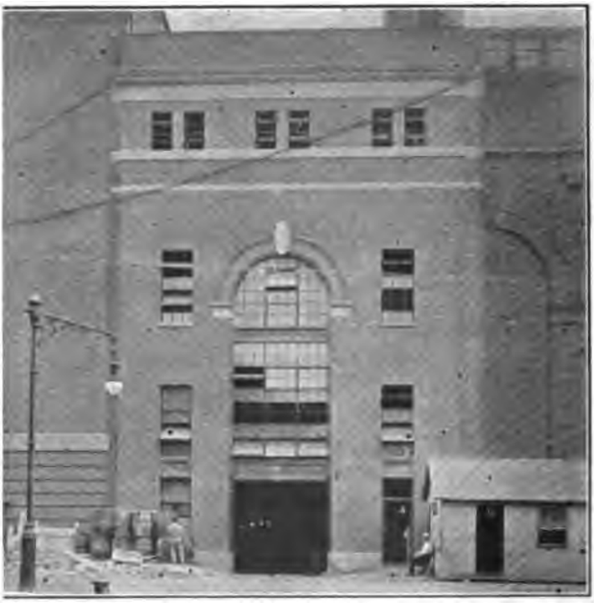


Fig. 140-22.—Shop and Wash House After Alterations Were Completed.

NO. 4 TURBO GENERATOR.

Continued demand for Edison Current and the assurance of more to come, led to the purchase, for installation this Fall (1916) of a 30,000 Kw. Westinghouse horizontal turbine to replace the old No. 4, a 9,000 Kw. Allis Chalmers unit, the new generator having about three and a half times the capacity of the previous one.

Investigation had shown the possibility of installing this turbine, with its immense condenser, twin circulating pumps and other auxiliaries, in very little larger area than that occupied by the former 9,000 Kw. Unit.

The dimensions of the new turbine are as follows:

Length	52 feet.
Width	22 feet, 9 inches.
Height	18 feet, 6 inches.

Total weight of Turbine Unit 480 tons.

Condenser, 40,000 square feet of cooling surface.

Weight of Condenser, empty	150 tons.
Filled with water	309 tons.
Length	27 feet.
Diameter	16 feet, 6 inches.

Some idea of the size of this unit is obtained by the following abstract from the specifications:

"When supplied with not less than 37,500,000 lbs. of water per hour, or 75,000 gallons per minute at the temperatures specified the condenser will maintain the following vacua referred to a 30-inch barometer when handling the amounts of steam mentioned below:

Temperature Injection Water.	Condensed Steam lbs. per hour.	Vacuum Inches.
60 deg.	194,000	29.07
60 deg.	375,000	28.80
70 deg.	194,000	28.80
70 deg.	375,000	28.50

The design of the structural steel platform to support the new turbo generator is shown in Fig. 23. You will note that it consists of a system of girders supported on six columns, the latter in turn resting on pairs of girders supported on grillages of I beams. The calculations for the structural work had to be based on the same deflection limi-

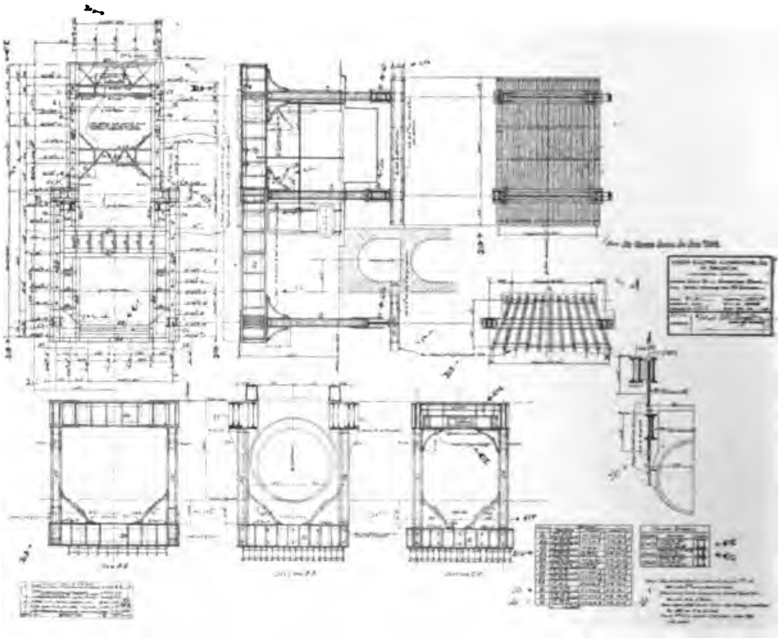


Fig. 140-23.—Steel Framing for No. 4 Generator.

tations and factor of safety as those of No. 3 which in the case of the increased loads of No. 4 turbine made the individual members, especially the girders of the upper platform, extremely heavy even for such a job, and the designing of the steel had to be done with extreme care for erection problems. The girders and grillage below the basement floor were fortunately very much simpler than those of No. 3 due to the absences of interference within the area of the foundation itself, but the position of the condensing tunnel, the hot well pump pit of No. 3 turbine and the condenser of No. 5 turbine on the other side left no room to spare in any direction.

The loads of the steel structure are as follows:

Weight of turbine and condenser on platform.

Loads on Columns 1 and 2—375 tons—187½ tons each.

Loads on Columns 3 and 4—470½ tons—235¼ tons each.

Loads on Columns 5 and 6—437 tons—218½ tons each.

The foundation for old No. 4 consisted of a hollow rectangle of reinforced concrete, supporting the generator end of the turbine and a solid column of the same material supporting the steam end, both of which including the condenser and foundations were supported on wooden piles driven to refusal in the fill underlying the operating room of the station.

After the turbine machinery had been removed it seemed a fairly easy problem to remove the concrete, but those who have tackled the removal of first-class concrete with heavy reinforcement will appreciate the difficulty in getting this foundation out of the way. The usual methods of drilling holes in close rows by means of steam and air drills were resorted to, followed by plugging and feathering and breaking out. It was not difficult to get off the layer of concrete outside the first row of bars, but the rest was an entirely different matter. Fig. 24 shows the appearance of this work in progress. Working as many men as could be used to advantage it took 26 days for an average of 24 men and six drills to remove the concrete to the floor level, the work from that point to the bottom of the foundation at mid tide level proceeding at different times as the layout of the work required.

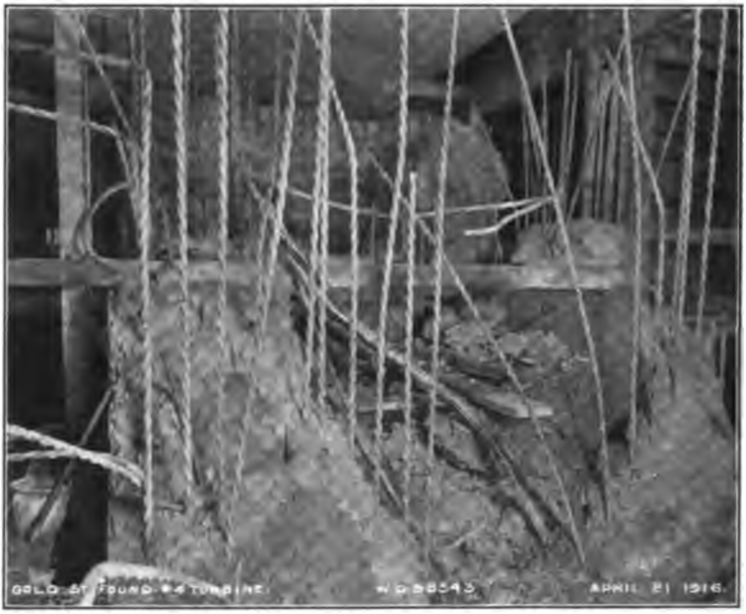


Fig. 140-24.—Reinforcement Uncovered in Old No. 4 Foundation.

In designing the foundation it was not possible to determine exactly what method was to be pursued in installing an adequate support below the level of the grillage until the condition of the old piles could be determined and borings made.

As soon as practicable borings were started, first with 3-inch, then with 6-inch pipes, all of which were stopped by obstructions before reaching satisfactory depths. A 14-inch steel shell was then tried excavated inside as driven, like the piles of No. 3 and this with entire success.

The 14-inch boring, however, while developing about the same poor soil conditions as those at No. 3 showed only a few stones and encouraged us to make an attempt to drive wood piles.

When the piles under the old foundation had been uncovered, pits of tongued and grooved sheathing were constructed, one large one on the westerly side of the tunnel to permit excavation around the piles to a depth required by the low level of the hot well pit, some 13 feet below datum and a smaller one on the easterly side. Some of the piles uncovered had been driven in 1896 under old engine foundations removed in 1906, and many of these were in perfect condition after being in the permanently wet soil twenty years.

All the piles whether original or driven for the previous No. 4 turbine were examined carefully and tested for dependency, the desire being of course to make as much use of them as possible. The smaller ones and those broomed in driving being removed during the progress of excavation. The testing was done by attempting to pull them with a double chain hooked on to the fifty-ton crane in the station, the chain being fastened with a noose on opposite sides of each pile tested, the pull given the pile being about ten tons. If the pile did not break in pulling and appeared satisfactory otherwise it was left in place and redriven later to ultimate refusal.

As settlement of the foundation was to be absolutely prevented at any cost it was felt that a maximum of ten tons per pile should be allowed and less if possible.

The total load at the base of the west grillage is 1,150 tons—the number of piles required under the west grillage at this limit was, therefore, 115, and of this number at the end of the testing it was felt that 49 of the old ones could be relied upon. This meant the driving of at least 66 new piles. Work was started with spruce piles about 20 feet in length with 12-inch cut-off and with the usual pyramidal cast-iron shoe.

The driving was started at the west end and proceeded toward the easterly end or toward the tunnel at the rate of about four a day.

As the space toward the tunnel contained more of the old piles and the driving was compacting the soil to an increasing extent, the work became more difficult and it was finally determined to use oak piles with a new type of shoe, due not only to the compacting of the soil, but also to the small stones in that part of the fill. The shoe, shown in Fig. 25 was designed especially for the job and proved very successful. Each of the old piles was tried with the hammer and driven to refusal where possible, the penetration on redriving piles that had refused to budge on pulling amounting to anywhere from 0 to 22 inches.

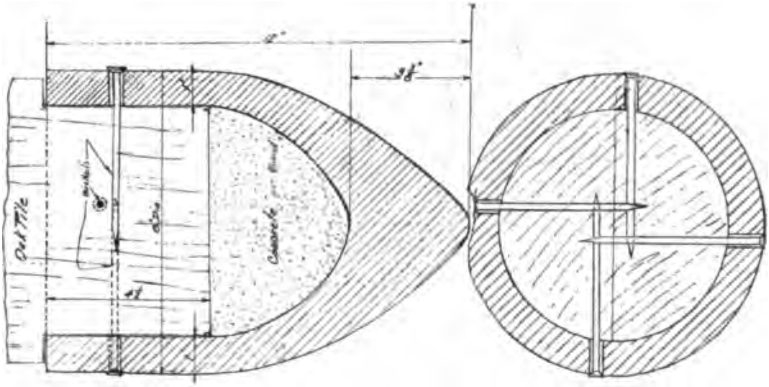


Fig. 140-25.—Pile Point.

At the completion of the work in the west pit there had been installed 81 spruce, 16 oak and one steel pile, that sunk for the test boring, all driven to successful refusal, together with 49 tested old piles, making a total of 148 piles and the average load per pile 7¾ tons.

On the other side of the tunnel a similar condition existed to that described except that the interferences were slightly worse on account of the position of a suction well at one end and a discharge casting at the other, both of which interfered with the placement of the piles. The testing and driving was repeated similarly on this side and the final result showed 26 old piles and 20 new oak piles. The load transmitted from the columns is 237.5 tons on each of the center columns and 188.5 tons on each of those on the westerly side. On the east side of the tunnel the total load on the grillage is 550 tons and the load on each side of the easterly columns to be transmitted to this grillage 218½ tons each.

Figs. 26, 27 and 28 show the grillage girders in place, the columns being installed and finally the steel platform completed.

Fig. 29 shows No. 3 unit complete and is typical of both turbine installations.

In the case of No. 4 turbine, the condenser instead of being supported directly on the foundation as in No. 3, is hung from the structural steel work itself. This design was adopted because it removes all possibility of trouble from unequal loading on the structural steel due to the pull of the condenser when under vacuum. This so-called "pull" is due to the fact that the very large nozzles through which the exhaust of the turbine passes into the condenser provide two large areas (170 square feet together) on which there is atmospheric pressure when the condenser is idle and 29-inch of vacuum when operating, a dif-

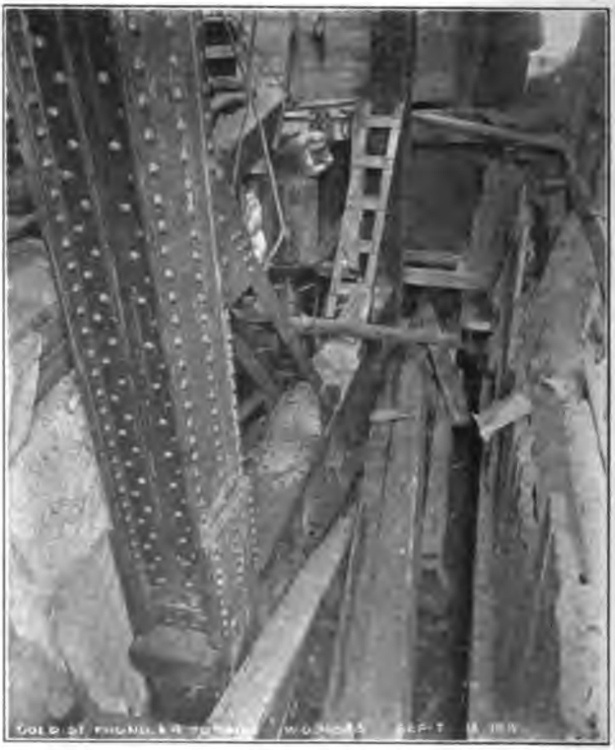


Fig. 140-26.—Grillage Girder Under Columns East of No. 4 with Columns in Place.

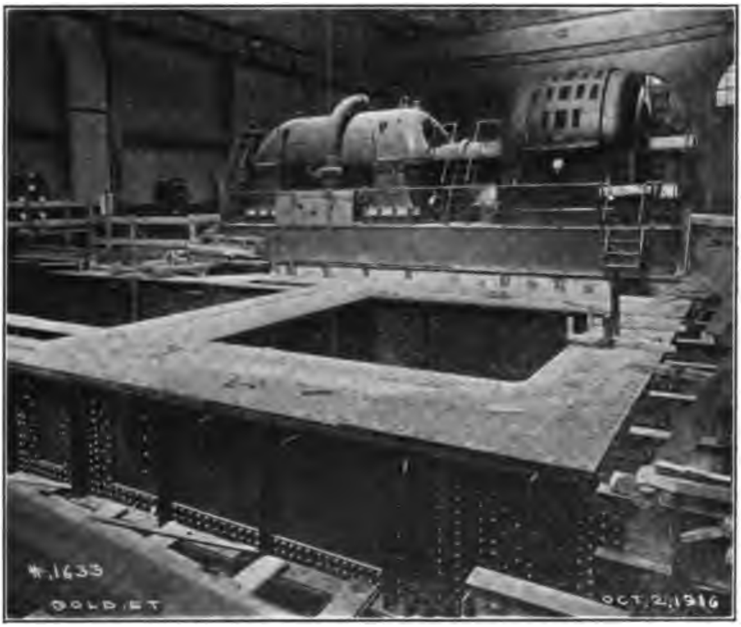


Fig. 140-27.—Steel Platform, Showing Generator End After Pouring of Concrete in Girders.

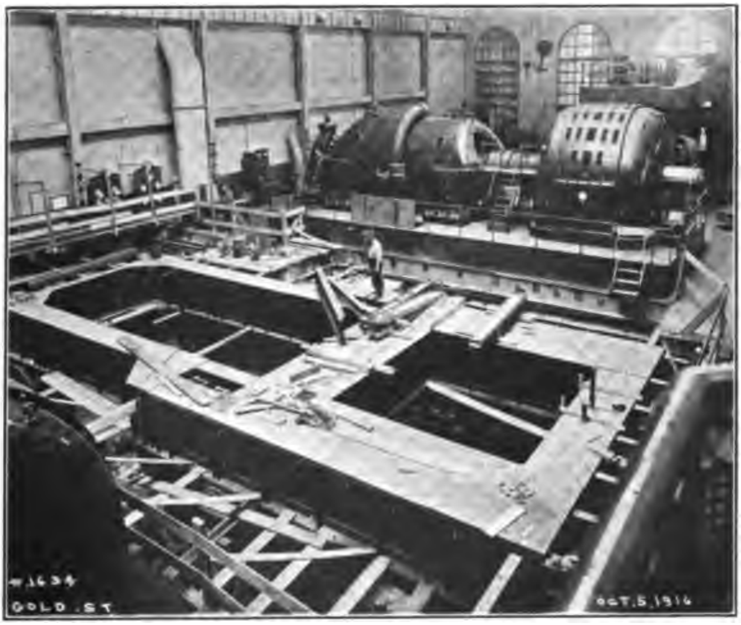


Fig. 140-28.—General View, Showing Steel Platform Completed from Above.

ference of 214 tons in the case of No. 4 and far from a negligible factor.

In the case of No. 3 turbine this made a difference of 108 tons load on the structural steel frame which had to be designed to take it, whereas, in the case of No. 4 the weight transmitted into the columns is the same at all times.

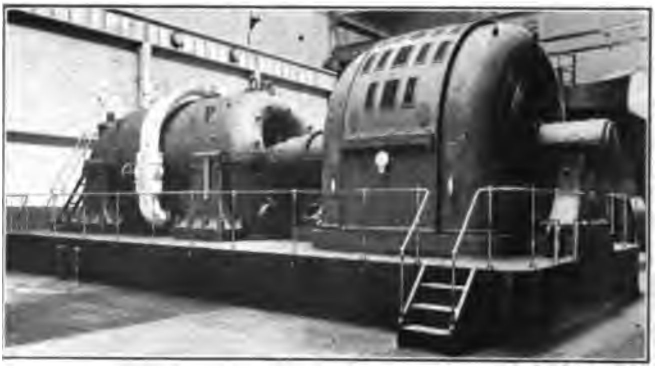


Fig. 140-29.—No. 3 Unit Complete.

Another problem in connection with this foundation was the sinking of two suction wells for the circulating pumps. Fig. 30 shows the section of the tunnels, the proposed position of these suction wells and the castings connecting to the pump. It was necessary to cut out part of the old suction

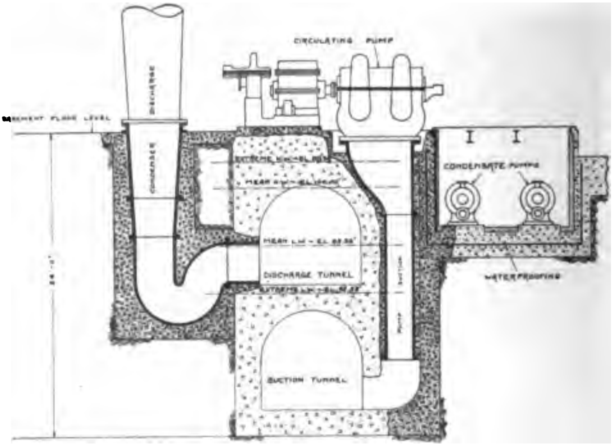


Fig. 140-30.—Section of Condensing Water Tunnels Showing Suction and Discharge Connections.

of No. 4 and part of the old suction of No. 3, too small to be used, to a depth of approximately 22 feet below the basement floor.

Before starting this work large bulkheads had to be installed by divers against the inside wall of the tunnel covering the present hole in the tunnel wall provided for the old suction and extending far enough on each side of these in each case to provide for the larger new opening as well. These bulkheads or doors were provided with fire hose as a gasket around the edge of the frame and held against the wall by jack bracing extending across the tunnel. The work was done in sheathed pits, the water being maintained below the work by pumping and the concrete cut away as we went down.

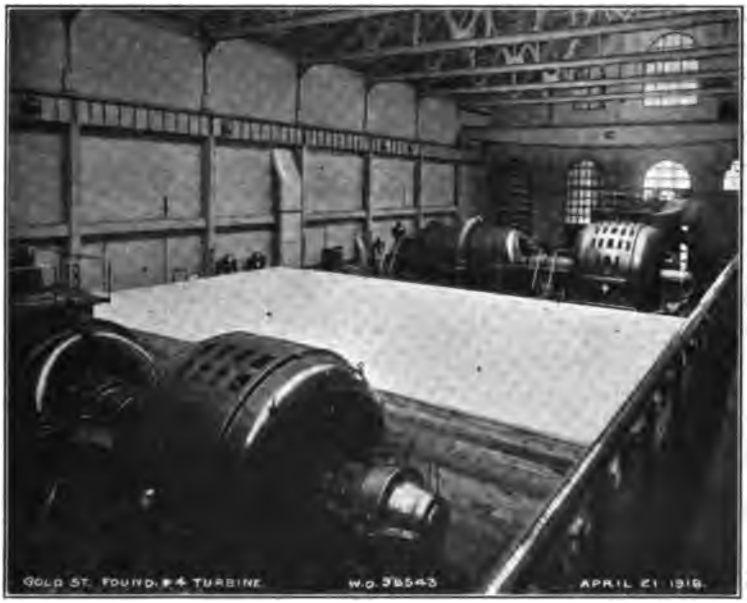


Fig. 140-31.—Cloth Covering Over Scene of Operations for Removing Old No. 4 Foundation.

When the concrete and earth had been sufficiently cut away, the suction casting was lowered into place, a form placed between its lower edge and the sides of the pit and the whole concreted in place. Concrete was then placed below the casting and rounded out to form an easy passage for the circulating water from the tunnel to the suction pipe after which the bulkhead could be removed.

In addition to the engineering problems encountered in the construction of the foundations described, some very unusual precautions accompany construction work of this importance, where the work has to proceed within the Operating Room of a generating station on which the population and industry of a large city depend for their light and power.

Before any drilling was started on the concrete foundation of old No. 4 a heavy board partition was built entirely around the area to be affected by the work, extending from the basement floor to the Operating Room floor with two doors kept locked at all times except when actually in use. In the basement from the enclosed area of the dock was constructed a boarded passageway for the entrance and exit of men and material. A fence seven feet high was erected on the Operating Room floor. Over the top of the partition was stretched a series of wires on which was hung a covering of cheese cloth as shown in Fig. 31 to prevent any possibility of dust from the drilling getting into the machines, and this remained in place until the concrete excavation was completed. All of which effectively separated the construction work from the rest of the station and resulted as was intended in making the operation of the station proceed practically as if no other work was going on.

In addition to the above all blasting is prohibited, even in peanut charges, pile driving is stopped during time of peak load in the late afternoon and no material is permitted to be carried by the crane over any machines in operation.

If it becomes necessary to have one or more of the turbines out of commission as in the case of divers entering the condensing tunnels, arrangements must be made at least a week ahead so that other provision may be made to carry the load, sometimes necessitating the starting up of the Company's other and older generating station at 66th Street, this being operated only as required by load conditions.

These are some of the precautions required on every construction job affecting operation in any way and are the constant safeguards against interruption of service.

In closing the author desires to acknowledge the helpful assistance of Mr. F. L. Hough and Mr. H. B. Morrison, both of the Engineering Department of the Edison Company in the preparation of the paper.

It is a coincidence worth noting that all of those concerned directly in all three jobs described in this paper are members of the Brooklyn Engineers' Club.

Mr. Bernt Berger, Consulting Engineer.

Barth S. Cronin, Contractor for No. 3 and No. 4.

John H. Duncan, Contractor for Shop and Wash House.

Charles C. Cain, Engineer for Contractor on No. 3; Superintendent for Contractor on No. 4.

F. L. Hough, Assistant Engineer, Engineering Department Edison Company.

H. B. Morrison, Chief Inspector Building Construction Engineering Department Edison Company.

J. J. Carroll, Inspector Building Construction Engineering Department Edison Company.

And the author.

DISCUSSION.

Bernt Berger.—The construction of the foundations so ably and interestingly described by Mr. Knight in his paper presented difficulties on account of the peculiar condition of the ground underlying the Gold Street Power Station.

A timber crib underlies the West wall of the old or North Boiler House, which crib seems to have turned East approximately under the West and East centre line of the Shop and Wash House, a corner of it being found in excavating the pit for Col. 5 of this building (an interior column), where the crib seems to have turned North again. Cribwork was found during the construction of the tunnels in the engine room, and also when the steel pipe piles were driven for Turbine No. 3. Evidently these cribs had lined old slips or basins, which were filled in at later dates. Greasy mud or muck had accumulated on the bottom of the old slips or basins, on top of which the later fill had been dumped. The sub-surface conditions are so irregular over the whole plot occupied by the station that no reliable conclusions could be drawn from observations and examinations made at one point as to the conditions existing at another point, even comparatively near.

The pressure on the base of the West and East piers of Turbine No. 3 is slightly less than 2 tons per sq. ft. The underlying material is fill, but the fill is of good sound quality down to the original surface, and was considered satisfactory material to rest on with such low pressure, all the more as a number of old wooden piles were uncovered in each pit and incorporated in the foundation.

In the case of the center pier of Turbine No. 3 the conditions were entirely different. On account of the conditions determining the spacing of the columns of the steel platform, the presence of the water tunnels and of pits for auxiliary machinery, it was not possible to design a pier which would give a pressure of less than 4½ tons per sq. ft. on the base. This was too much for the underlying material, which is fill on top of the accumulation of greasy, oily, black mud on the bottom of what was apparently an old slip. Timber piles could not be driven in sufficient number and of sufficient size to the required depth. Hard driving would cause so much jarring as might seriously disturb the foundations of the adjacent vertical turbine, which rested on the earth fill without piling, with a pressure of about 2 tons per sq. ft. Steel pipe piles were adopted as described by Mr. Knight, and the open bottom was selected in order to make the driving easier. No disturbance of the adjacent vertical turbine was observed. I believe that with the final load and the final arrangements of the piles the load per pile proved to be about 23½ tons.

In the case of Turbine No. 4 Mr. Knight found it possible to so design and arrange the main and auxiliary machinery and the steel platform structure that on the main or westerly portion of the foundation the load per square foot on the base of the foundation was reduced to about 2½ tons, practically uniformly distributed.

The material underlying the main portion of the foundation was again fill, on top of the same greasy, slippery black mud as was found under Turbine No. 3. Over the greater portion of the space the excavation uncovered the wooden foundation piles of the old turbine which had been removed. These piles belonged to two different dates of earlier construction, and many of them were small, not more than 7″ or 8″ butt, while the more recent piles were nearly 12″ butt. Some of the piles, especially the older ones, were pulled in an attempt to judge of their length and condition. The rest were given some driving and were incorporated in the new foundation, and new piles were driven in vacant spaces and to replace the pulled piles, all as described by Mr. Knight. It was considered necessary to get a foundation for the delicate machinery to be supported, below the black mud, as it is of the greatest importance that no unequal settlements occur. In this connection it should be noted what Mr. Knight says about the limits of deflection of the steel platform required by the builders of the turbo-generator.

In the East pit for Turbine No. 4 a number of old wooden piles were utilized for the new foundation. They were good-sized piles, 9″ and up to nearly 12″ at the upper end. Attempt was made to pull some of them but they did not budge, except one which broke off about 4 ft. from the upper end, where it had been crushed in the driving. The material was fill, but there was no underlying black mud. A number of new piles were driven also here.

The Shop and Wash House was also on filled ground, and some of the fill was the merest rubbish. Some black mud and oily, black sand were found, as far East as the building line on Gold Street. Near the Gold Street side the lower, original, strata seemed to have been loosened, perhaps from the excavation for the large sewer which was built some years ago along Gold Street.

The different operations were carefully and conscientiously carried out, and I wish to pay a tribute to the interest and care displayed by the organization of engineers and inspectors engaged upon the work and their spirit of loyalty to Mr. Knight and the Edison Company throughout.

F. L. Hough, Jr.—In the majority of steel designs, strength is the determining factor, but in the design of the steel foundations for the large machines covered by tonight's paper, deflection is the determining factor.

In general, deflections vary as to the total load on the span and as the third power of the length of span, or with a uniform load per foot such as is approximately the case here, the deflections vary as the fourth power of the length of span; in other words the deflection for a 30-foot span is 16 times the deflection for a 15-foot span, and to keep the deflection the same for each span it is necessary to have the moment of inertia of the section of girder used, 16 times as great for the 30-foot span as for the 15-foot span; hence it follows that it is economical to use short spans by introducing intermediate columns.

Unfortunately for the designers in the two foundations under consideration the condensers are some 2 ft. or 3 ft. greater in diameter than the bed plates of the machines and the columns had to be placed at the ends of the condensers which are about 27 ft. long. The location of these columns was further restricted by the location of the circulating pumps. The body of the condenser limited the depth of the girders so that this combination of circumstances resulted in very heavy girder sections in order to keep within the limit of deflection of 1-50".

The resulting unit stresses are low as pointed out by Mr. Knight, being about 4,000 lbs. per sq. in. for the girders of No. 3 foundation and about 3,000 lbs. per sq. in. for the girders of No. 4 foundation. This explains the very heavy appearance of the steel work as shown on the slides.

The heaviest single girder for No. 4 foundation is 27 tons. The total weight of steel in this foundation is 250 tons, to carry a total weight of about 1,100 tons, including the weight of turbine and generator, condenser which hangs to the steel work, and dead and live loads of the operating room floor adjacent.

In addition to the types of piles driven at Gold Street as mentioned by Mr. Knight in his paper, another type, the description of which I think would be of interest to the members, was used in 1912 in underpinning the walls of the North Boiler House.

The North Boiler House is carried on a structural steel framework with outside brick curtain walls. Along the West side of the building columns and wall are supported by a concrete footing about six feet deep, resting on timber crib of heavy timbers. Elevations taken at intervals along this wall after the appearance of many cracks in the brick wall showed that the columns and wall at the river end were gradually settling. To stop this settlement it was decided to remove the wall, put in pile foundations between the columns and rest heavy steel girders on the new foundations with the ends of the girders riveted to the old columns. In case of further settlement the girders acting as cantilevers would transfer the load of the columns to the new foundations. In order to drive the piling it was at first intended to sink sheeted pits, cut away the cribbing and drive wood piles, but the scheme was given up owing to the fact that the cribbing was so far below low water and it would be almost impossible to keep the water down. The work was finally carried out in the following manner:

The concrete wall was cut away by the use of air drills and plugs and feathers. A 16" diameter hollow steel shell 15 ft. long was set in place and through this a cast-iron hammer, 14" in diameter and weighing about one ton, was dropped. The lower edge of the hammer was provided with a cast steel cutting edge shaped like the cutting edge of a rock drill. This hammer, due to its weight and drop of about 12 feet, cut its way by degrees through the crib, boulders or anything encountered. As fast as the hammer made a gain of about 2 ft. it was followed up by driving the casing. When the hammer had finally cut its way through all obstructions, as determined by a 2" pipe driven inside the larger pipe, the casing was cleaned out and a wooden pile of predetermined length driven inside the casing to refusal in the old beach below the fill. There was very little cleaning of the casings to do as the fall of the hammer sent a stream of water, pulverized wood and stone out of the top of the casing to a height of 20 to 30 feet at each fall. Finally concrete was poured inside the casing and around the wood pile. These piles were designed to carry 20 tons.

The scheme as adopted proved entirely feasible and every pile was driven without undue difficulty except in one case where the driving crew cut too far before they followed up with the casing with the result that the hammer became caught under the casing and could not be withdrawn. The contractor tried to remove the casing by means of heavy chains and 30-ton hydraulic jacks. The casing, however, was so securely wedged in the concrete and crib work that it could not be withdrawn. The casing was then concreted over the hammer.

As a test to determine just what the hammer would do, one hole was cut entirely through the six-foot concrete footing wall

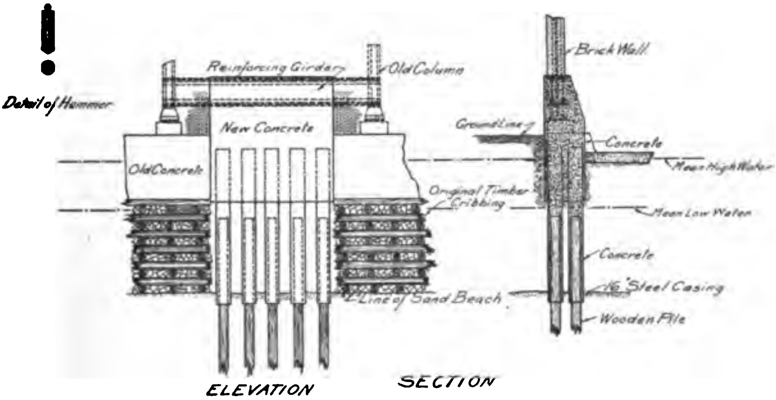


Fig. 140-31.

by dropping the hammer. This hole was cut through in about 12 hours.

The accompanying sketch, Fig. 31, shows the new piles and method of carrying old columns.

H. B. MORRISON—Many curious conditions were encountered during the progress of the work described in Mr. Knight's paper.

While the excavation of the material in the steel piles for No. 3 Turbine foundation was going on, a brick, a granite block and some hair mortar was brought up in the Hayward bucket from a depth of thirty feet below the level of Gold Street, and at one point there was quite a deposit of iron pyrites. The small boulder gripped in the bucket which was shown on the screen is flint, measures 8½"x10½" and weighs 26 lbs., showing the possibilities of the bucket.

In the foundation for No. 4 Turbine a number of the old wooden piles were dug out and in several cases there was a very good demonstration of what happens when a pile is abused. Some of them were broomed for three feet from the end and one or two piles had broken off about four feet from the point and the upper section had been driven longitudinally through the piece broken off.

The projectile points designed for the steel piles under the Shop & Wash House proved to be very efficient. In several cases driving was started on a pile and after it had penetrated a few feet it would strike an obstruction. In such cases driving would be continued up to the point of possible damage to the pile with the hope that the point might pass through the obstruction. When it was found to be impossible to make this penetration, the pile was withdrawn and in no case had there been any impression made on the projectile point.

A number of the piles, however, were driven through very hard material and in one case the point broke through a boulder about two feet thick and the pile was then driven to refusal in good soil.

A peculiar failure of a steel shell was encountered in this work. One of the shells had been driven about five feet in the ground when the point struck an obstruction. During the process of trying to force the point through, the steel pile sheared completely off on a level with the ground and at right angles to the axis of the pile. This, however, was an isolated case, and, in general, the shells stood the punishment exceedingly well.

BROOKLYN ENGINEERS' CLUB

No. 141.

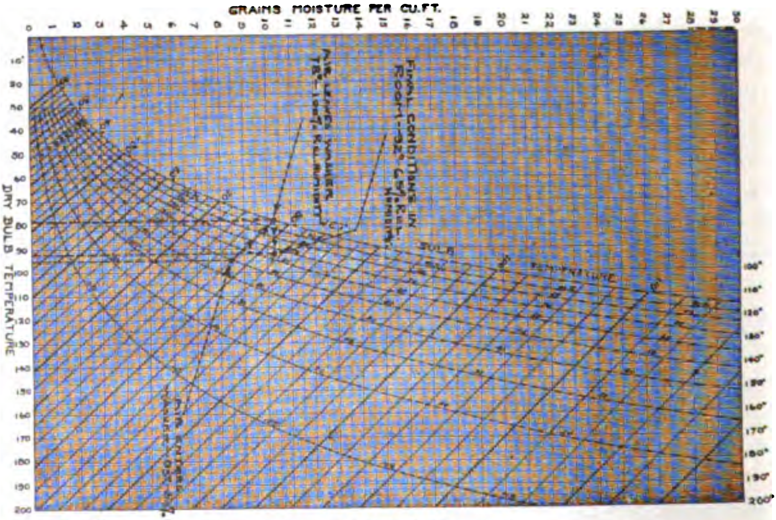
AIR CONDITIONING IN INDUSTRIAL PLANTS.

By Walter E. Heibel, Mem. B. E. C.
Presented November 9, 1916.

Engineers and manufacturers have ever before them the question of increased efficiency in their plants. In the early days of the factory system they were devoting their time principally to the design of labor-saving machinery. Any device that would produce a product in less time than some other device, or that would produce a better product, would immediately supplant any machine used previously. In the course of time machinery became more or less standardized and it was necessary for the engineers and manufacturers to look about for new fields for increasing the efficiency of their plants. For instance, a lathe today is practically the same as it was twenty years ago; that is, the principle is the same, and so it is with most of the standard machines in our factories. The aggressive manufacturer then found that the efficiency of the individual workman in his factory was not at all up to the maximum, and the next field for development toward an increased efficiency was to get out of each employee the maximum of work possible. We refer here to the conditions under which the operators would work: better sanitary conditions, good ventilation, light, etc., in the factories. It is true that a good deal of development along this line was due to coercion on the part of the Government, but any wide-awake manufacturer could see that a better product could be produced when these conditions in his factory had proper attention. But, like the machinery in his factory, these sanitary conditions and ventilating and lighting systems became more or less standardized, and he was forced to look for still another field to better the efficiency of his plant. Right here is where we come to the question of air conditioning.

From the foregoing we have pointed out that increased efficiency could be obtained by efficient machines, and the value of good working conditions for the operators; and now we will discuss the effect of better working conditions upon the product.

Take, for instance, a hat factory. The manufacturer will say, "Why can I make better hats in July and August than I can in winter months?" The answer to him is, "What you need in your factory is apparently a high temperature and a relatively high humidity. You should keep these atmospheric conditions in your factory constant, and if you do so there is no reason why your hats in January should not equal the quality that you have in July and August." The baker will ask you why it is that he cannot manufacture biscuits with a coating of icing during the hot summer months, whereas during the winter months this product can be made without any trouble. The answer to his question is just the opposite from the previous one. What the baker needs for this business is a relatively low temperature and a low humidity. He must maintain these ideal conditions the year round regardless of outside weather conditions if he wants a uniform product.

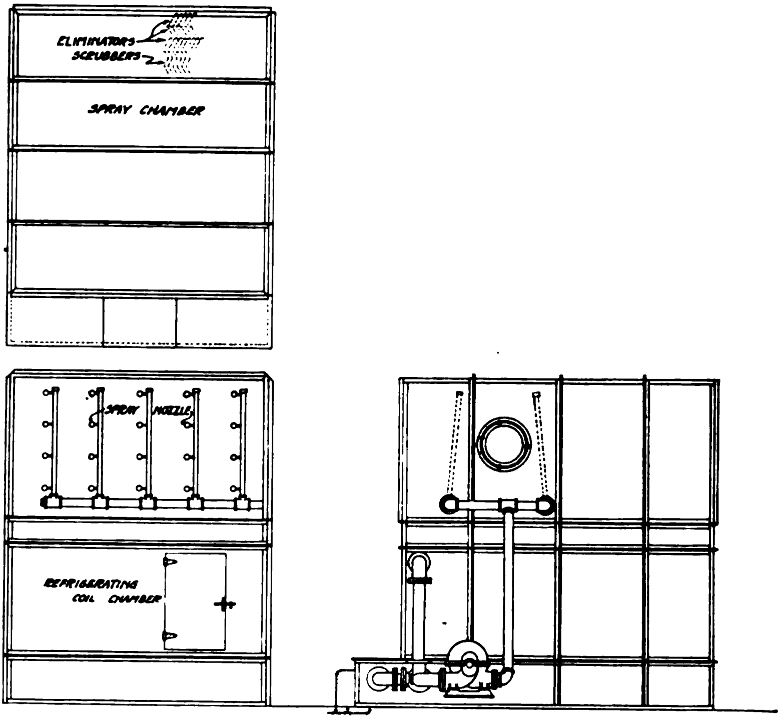


T-A-316 HUMIDITY CHART

We will now consider the question of humidifying, which is the first and the most simple branch of this class of work, that is, the adding of moisture to the air. During July and August, we have a relatively high temperature with a correspondingly high humidity. During the winter when the temperature is around thirty degrees the humidity outside may be relatively high, but when this air is heated to room temperature of 65 to 70 degrees the relative humidity decreases, and instead of having a humidity of 50 or 60 per cent., such as we have during the summer months, we have a humidity of 10 or 15 per cent. Now in such industries as the textile industry, or the felt hat industry, the "dryness" of the air produces an effect called "static electricity," which makes it impossible to work the product properly. Again, as you know, a piece of cotton string is stronger when it is wet than when it is dry. Hence, if the atmosphere in which textiles are manufactured is too dry, the fibers are more apt to break than in one that is more moist.

Before going further into details of their uses it might be well to describe briefly the standard air conditions. In every well designed conditioner there must be three elements: the spray chamber in which the air will become saturated; a series of wet scrubbing plates, and a series of eliminator plates. The particles of dust that absorb moisture will become heavy and drop into the tank while passing through the spray chamber, but such material as oil particles and cinders will not absorb any moisture and must be impinged against the wet scrubbing surface and be washed down into the tank. The eliminator surface is used for extracting any entrained moisture that may be carried along by the air, therefore when the air leaves the washer it is approximately 100 per cent. saturated, but does not contain any free moisture. The attached cuts illustrate the standard types of washers that are on the market.

In hat factories a higher humidity is maintained than anywhere else. You are all cognizant of the process through which a felt hat must go before it is a hat. The fur is blown onto a perforated cone about thirty inches high and is held there by the suction of an exhauster placed directly beneath the machine. Wet burlap cloths are placed over this cone and the cone is revolved. The action of the suction with the wet cloths placed over the fur starts the felting process and after a few moments of this treatment the hat is removed and the remainder of the felting is done by hand. If the air in this room does not contain the proper percentage of humidity, this fur, when blown onto the forming cone, will be drawn to the sides of the cone shell, due to the static electricity. This action is the same as you will observe when drawing a comb through your hair on a dry day. The hair will have a tendency to come up to meet the comb. If the atmosphere were not so dry this effect would not



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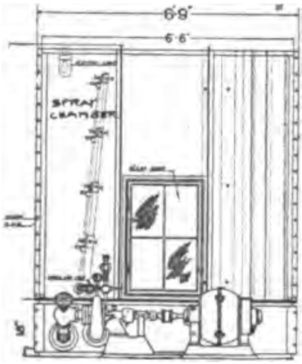

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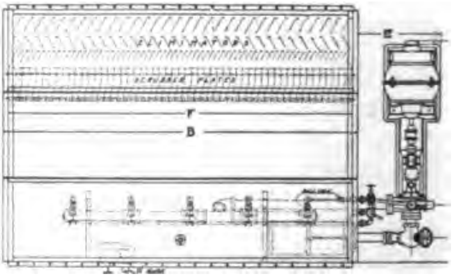

PLAN

be produced, and it is this effect that we must overcome in felt hat factories. A manufacturer recently stated that during the past year he lost ten thousand dozen hats, due to improper humidity conditions in his factory. Some manufacturers produce this humidifying effect by steam jets, but this is a rather costly method and produces too high a temperature.

There are several other industries that require a condition in the factory of high humidity, among which are the following:

Textile Mills.
Lithographic Plants.
Tobacco Factories.
Yeast Factories.

The second use to which air conditioners are put is just the opposite to the foregoing, or de-humidifying; that is, extracting moisture from the air. This requires some method of refrigeration in order to cool the air below the wet bulb temperature. It is easy enough to cool down to the wet bulb temperature, for this is done by evaporation, but beyond that point some outside means must be employed to get the proper results. The usual method is to place cooling coils directly beneath the air washer tank and let the water, after passing through the sprays, trickle down over these cooling coils into the tank at the bottom, and from here to pump it again up through the sprays.

Humidity control can be obtained by mixing the water from the upper and lower tank by means of proper connection through a three-way valve. This will control the temperature of the air leaving the air conditioner, and hence the resultant humidity in the room. As we have said before, the air leaving the air conditioner is always 100 per cent. saturated. If we desire to maintain a temperature below the outside temperature, and with a humidity lower than can be obtained by evaporation, we will have to carry our air down to a temperature considerably below that which we desire in the room. To illustrate, we will take a temperature of 60 degrees and a humidity of 60 per cent. for our resultant room conditions. We will have to pass our air through the conditioner where it will be cooled to a temperature of 45 degrees—100 per cent. relative humidity. We have previously determined the volume of air necessary to overcome the heat gain in the room to be conditioned, this gain being due to machinery and heat producing apparatus in the room, and the transmission of heat through the walls from the outside. This gives us a certain heat balance and fixes the rise in temperature of the air from the time it leaves the apparatus until it has diffused in the room. After having determined this rise, which in our example is 15 degrees, we will have the resultant conditions of 60 degrees and 60 per cent. relative humidity. Were we to circulate one-half the volume of air the rise in temperature would be about double, in order to make a correct heat balance.

We find this latter type of apparatus in use in candy factories, bakeries, lithographic establishments, rubber mills, etc. In addition to the fact that the atmospheric conditions can be held under control as regards the temperature and humidity, we have the advantage gained from pure clean air; that is, with at least 95 per cent. of the solid matter removed.

There is still another use to which air washers are put, and that is in connection with generator cooling. For some time large generators have been cooled by external blowers, but it is not until recently that any attempt has been made to cleanse this air before putting it through the generator. At first dry filters were common and for small installations this is a very efficient way of cleaning the air, but on account of the fact that there is considerable work entailed in cleaning out the screens they have been found objectionable on large installations. Therefore, wet filters were found to be the best adapted to the cleansing of air for large units, and it was not long before the cooling effect was recognized as being just as valuable as the cleansing. It is possible to increase the efficiency of any generator considerably if the air entering the generator can be lowered below the outside temperature. As an example, we will take the following to show you how you can increase the output of a generator by installing an air washer. Most generator manufacturers specify a temperature rise of 104 degrees Fahrenheit through the windings. The outside air would be at 95 degrees during extreme summer conditions, with a wet bulb temperature of say 75 degrees. If the temperature outside is 95 degrees it would not be uncommon to find a temperature as high as 105 degrees in a generator room, which, added to our allowable temperature rise of 104 degrees, would give us 209 degrees Fahrenheit as the temperature of air leaving the generator. Now the air in passing through the air washer would lower to the wet bulb temperature of 75 degrees. We can count on a temperature rise of about 2 degrees in reaching the generator, so that the air entering the generator would be 77 degrees Fahrenheit, as against 104 degrees if the air is taken from the generator room. Therefore, we have an additional rise in temperature of 27 degrees, or approximately 1.27 of the temperature rise that would be allowed for our generator, with air at room temperature. This means that there is 34 per cent. more heat being carried away. Heat varies directly, as resistance of electrical circuit. Also resistance varies as the square of the current. Therefore we would have $\sqrt{}$ 1.27, or 1.13 or 13 per cent. more power available if the air conditioning apparatus is used.

Another use for which air conditioning apparatus of this nature has been used is for re-conditioning material, such as cardboard, etc. Here it has been found that a temperature around 70 or 80 degrees with a humidity of 95 to 98 per cent. is more efficient for putting moisture back into material than a temperature higher than this—say, around 110 to 115 degrees. with a relative humidity of 95 to 98 per cent.

DISCUSSION.

MR. HERBERT C. KEITH, Mem. B. E. C.: Do you know what temperatures and percentages can be maintained or would be desired for the various rooms in a spinning mill?

MR. HEIBEL: The turning room will want about 60% and the spinning room will want a little greater; the weaving room about the same as the spinning room. I don't know anything at all about linen, but I imagine it would be about the same as cotton. Cotton mills will often have a humidity as high as 80%. They go as high as they can without complaint from the workers. Although the air is sometime much cooler and the workers are still not comfortable that is when the humidity is extremely high. I have in mind one case where the temperature outdoors was 92 and the temperature inside was 87 but the workers insisted upon having the windows open because the air outside was cooler.

MR. AUGUSTUS J. KOEHLER: Is that the same system we have in the iceless ice-box?

MR. HEIBEL: Probably the same thing; there they have coils and blow air through coils; they don't attempt to wash it.

MR. F. L. HOUGH, JR.: Is it not practical to install such a system in a dwelling house and keep the temperature and humidity between comfortable limits at all times of the year?

MR. HEIBEL: Such a system has been installed recently for a man who wanted a temperature of 60° with comfortable range of humidity in his house. To do this it was necessary to lower dew point to about 42° and then heat the air to 60°.

MR. AUGUSTUS J. KOEHLER: How do you overcome the velocity of the air and the effect of the moisture? Assuming that you have a high degree of velocity, how can you carry the moisture with it? Assuming that you want to ventilate this room and you put through a high velocity of air, how do you control your moisture where the velocity is greater than the ordinary condition?

MR. HEIBEL: Two methods; in the summer time by operating the dampers in the room; in the winter we put a heater on a suction pump and inject steam in the spray water so that the temperature of the spray water will be high enough to give it a proper degree of humidity when it diffuses into the room.

MR. HERBERT C. KEITH: In a room 200 feet square with average height of 16 or 17 feet with an air conditioning plant at one end of the building, how close could you keep the temperature and how close the humidity, and how much power would it take to keep the temperature as close as possibly 70 to 75 degrees and the humidity 80%; for the most extreme case, and the average for the year?

MR. HEIBEL: You can control the temperature within one degree and you can regulate the humidity within 5%, no closer. And as for getting 75 degrees and 80% humidity, you could not do that without a refrigerating apparatus. In summer time you have wet bulb temperatures as high as 78 degrees and when you raise the temperature and get 80% saturation you would have 85 degrees. If you haven't cold well water you would have to put in refrigerating machines. Just as soon as you start to de-humidify it is just like a sponge—you can squeeze it until you get water out of it and you keep on squeezing until you get no more water. It would take 30 horse power; the fan for circulating air would take considerable more, probably 60 horse power. This is figuring the worse condition.

MR. KEITH: Now for the average for the year—the average horse power to maintain this temperature?

MR. HEIBEL: In the winter time you would have to circulate only about one-quarter as much air as in the summer, and, of course, it would take about one-quarter of the horse power; but the washer horse power would be the same; it would take probably 15 horse power on your fan and 30 horse power for the washer.

In answer to a question, Mr. Heibel stated that in the summer when you are humidifying you should never take any re-circulated air. It should be all fresh air. It must be always from the outside so that you get air with a wet bulb temperature of 78 degrees. In the winter it is customary to re-circulate part of the air in order to circulate heat. Take, for instance, where you want to maintain a certain humidity and that humidity goes too high, the humidity regulators will operate the dampers and admit a certain amount of fresh air which will be lower in percentage of moisture than the re-circulated air and thus will tend to lower the total humidity. If the humidity is too low and you want to get it up, then your fresh air dampers will close and your re-circulating air dampers will open, and you will then be taking air round and round the system until the humidity reaches the proper point.

MR. VAN NORDEN, Mem. B. E. C.: This machine you have shown. Is that the same type as that used for cooling gases?

MR. HEIBEL: The same principle applies. I think the Metropolitan Engineering Company of New York has devised some kind of a device to blow air down into the water.

MR. VAN NORDEN: The temperature is not a matter of any moment in connection with this cleansing.

MR. F. H. POND: It seems that in these plants the welfare of the individuals is neglected in favor of the efficiency of the product. Isn't there a point where it might be wise to ventilate in the interest of the employees rather than putting the expense in the product?

MR. HEIBEL: There are some industries where you can't work up a product without proper atmospheric conditions.

MR. POND. Is this apparatus similar to that used in re-icing air which is circulated?

MR. HEIBEL: We've made some experiments in Toledo at a school house. They built an addition to the school. One-half had the humidity control and the other the old system of pumping fresh air from the outside. To show the influence on the pupils it is interesting to know that the general health of the students was 10% better than in the un-conditioned portion of the building and the promotions were 12% greater and the standing was 8% better. They have that figured out in dollars and cents too. That is the influence on the individual.

MR. VAN NORDEN: But you don't think the conclusions drawn from that experiment in Toledo are conclusive?

MR. HEIBEL: I would not want to take those figures as positive, no. But the Philadelphia school board has established a Municipal Board of Research, or some such board, and for two years have had similar experiments and found that a temperature of 67 and 68 degrees with relative humidity between 55 and 60 per cent. is better than a temperature of 75°F. with the humidity less than 50 per cent.

DAVID BROWER.

MEMOIR OF DAVID BROWER.*

DIED FEBRUARY 14, 1916.

David Brower was born in the City of Brooklyn on October 22, 1842. His early education was obtained at the public schools of the former city of Williamsburg, later known as the "Eastern District" of Brooklyn.

At the first call for troops in 1861 Mr. Brower enlisted in the Thirteenth Regiment, and on a second enlistment, in 1862, he went to the front with the Forty-seventh Regiment, and after two years of war service returned to Brooklyn as captain of his company.

In 1865 he was promoted, after serving as rodman and leveler, to be assistant engineer in the Department of City Works of Brooklyn, and in 1870 was placed in charge of sewer construction.

This position he held until his retirement on June 1, 1915.

His circle of friends was nearly the same as his circle of acquaintances, for every one who knew him felt strongly drawn by his sturdy, self reliant but always kindly manner.

He was a charter member of the Brooklyn Engineers' Club and always interested in its welfare.

He was a member also of the Veteran Society of the Forty-seventh Regiment, N. G., N. Y., of Hyatt Lodge No. 205, F. & A. M., of the Eckford and Hanover Clubs, the Holland Society and the St. Nicholas Society of Nassau Island. Mr. Brower is survived by three sons, David, Edward S. (member of the Brooklyn Engineers' Club) and Frank D. Brower.

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* Memoir prepared from Club records by the Secretary.

FRANK J. CONLON.

MEMOIR OF FRANK J. CONLON.*

DIED JUNE 28, 1916.

Frank J. Conlon was born in New York City in 1871. While still quite young his father removed with the family to Brooklyn and he attended the public schools of the former City of Brooklyn, Pratt Institute and graduated later from St. Francis College.

In his early business life he was associated with his father in building operations, and in 1895 accepted a position as Assistant Engineer in the Bureau of Sewers of the Department of City Work, Brooklyn, and after the municipal consolidation he retained his position and continued his work, the design and construction of sewers for the Borough of Brooklyn.

When the Brooklyn Engineers' Club was formed in 1896 he became a charter member of the Club and continued his active and helpful interest in it to the last, giving time and energy to the work of Librarian of the Club, which office he had accepted at the request of the Directors and held for four years.

Mr. Conlon was an associate member of the American Society of Civil Engineers and a member of the National Geographic Society. He is survived by his widow, Ella T. Fennell, and their two sons, Fennell F. and Raymond W. Conlon.

Mr. Conlon possessed a charming personality and an even and agreeable temper that attracted and retained the warmest personal regard of a large circle of friends.

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* Memoir prepared from Club records by the Secretary.

WILLARD P. HOUGH.

MEMOIR OF WILLARD P. HOUGH.*

DIED MAY 8, 1916.

Willard Parker Hough was born at Media, Pa., on February 22, 1880, and graduated from the Williamson School in 1900 after completing a course in architecture.

After his graduation in architecture and until early in 1904 he was engaged in bridge and structural steel work with the Edgemoor Bridge Co., The Phoenix Bridge Co., the Brown-Ketchum Iron Works and other large corporations, in charge of shop details for various constructions.

In 1904 he came to New York as Assistant Engineer with the firm of Boller, Hodge & Baird, and was actively engaged in designing the reinforcement of the elevated railway lines of the Brooklyn Rapid Transit Co. until that work was taken over by the company.

After some years with other companies he returned to Brooklyn to become assistant structural engineer for the Brooklyn Rapid Transit Company's portion of the Dual Rapid Transit System, and continued in that work until his death.

On October 12, 1905, Mr. Hough was elected to membership in the Brooklyn Engineers' Club, in which organization he was deeply interested, attending its meetings very regularly and contributing frequently to the discussion of the papers read before the club.

Mr. Hough was well known as an engineer and was also an active lodge man, belonging to several Masonic bodies and other orders. His summer home was at Patchogue, L. I., where he was identified with the South Side Yacht and Field Club. He was a former vice-commodore of the Bergen Beach Yacht Club, Brooklyn.

He was a vestryman in St. Paul's Episcopal Church, Patchogue; and was a member of South Side Lodge, No. 493, F. & A. M., Patchogue; Suwassett Chapter, Royal Arch Masons, Patchogue; Patchogue Lodge, No. 13,323, B. P. O. E.; Gilbert Council, R. A., Brooklyn, and of the Patchogue Volunteer Fire Department.

Mr. Hough was interested in the development of Long Island and was a member of the Long Island Waterways League, which is backing the project of an inland waterway along the

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* Memoir prepared from Club records by the Secretary.

South Shore. He was interested in preparedness and had signed for the Plattsburg camp.

Mr. Hough leaves a widow, who was Miss Blanche Edwards, a daughter of the late Dr. Lawrence Edwards of Patchogue. He also leaves a son, Lawrence Edwards, six months old; father, and mother, Frederic Lewis and Isabel Parker Hough; three brothers, Frederick Lewis, Jr., Calvin C. and Leslie Seymour Hough.

Mr. Hough's pleasing personality and sterling character had won for him a large circle of friends, who sympathize with his family and grieve over his untimely death.

His sympathetic and kindly manner won him hosts of friends and his untimely taking off was keenly felt by all. It seemed to each one who knew him that a close personal friend was gone. He will be long remembered.

MEMOIR OF THOMAS A. DOYLE.*

Died November 4, 1916.

Thomas A. Doyle was born in New York City on May 22, 1889. He graduated from St. Peter's High School, New York, and later studied engineering and in 1908 graduated from De La Salle Institute.

From that time until his final illness he was usefully employed on a variety of projects, including surveying and road building, railroad tunnel work, water supply and street construction.

He was elected a member of the Brooklyn Engineers' Club on October 9, 1913, and at once became interested and active in its work.

He was of pleasing manners and made many friends and his loss will be felt by all who knew him.

He is survived by his widow, who was Miss Mary McCaffrey, and a daughter.

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* Memoir prepared from Club records by the Secretary.

THOMAS A. DOYLE.

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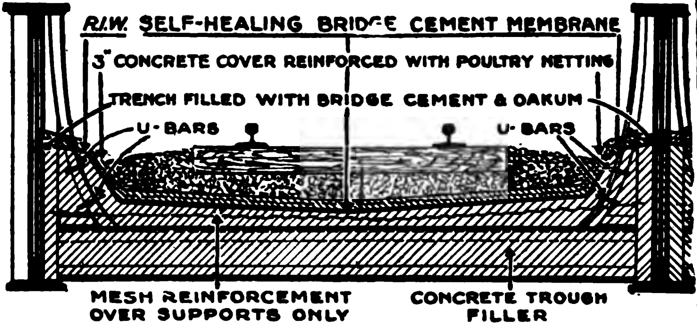
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